AMERICAN ENGINEER AND RAILROAD JOURNAL.

SEPTEMBER, 1901.

CONTENTS.

FOUR-CYLINDER TANDEM COMPOUND LOCOMOTIVE.

Consolidation Type.

Northern Pacific Railway.

After a year of service on the Northern Pacific Railway the experimental four-cylinder tandem compound locomotive, built by the Schenectady Locomotive Works, has been found satisfactory and these builders are engaged upon an order for 26 for that road, the drawings of which have been supplied for this description by the American Locomotive Company. In addition to these an order for 40 of the same type has been given by the Atchison, Topeka & Santa Fe. Comments upon the selection of this type will be found in the editorial columns of this issue.

This engine will be known as Class Y2 and will be used in freight service on the Pacific division. The consolidation engines on this road of the two cylinder compound type, Class Y1 (American Engineer, Feb., 1899, page 42), have 55-in. driving wheels. With 63-in. drivers the new class will be available for fast freight.

The chief interest in this design centers in the cylinders. Only one pair of saddle castings are used, the cylinders are cast separately, the low pressure with the saddle and the high pressure cylinders being mounted upon the front faces of the low-pressure cylinders with a single head between. Piston valves are fitted to both cylinders with a continuous passage between. This forms the receiver, and by making the valves hollow, arranging the high pressure valve for inside admission, the low-pressure valve for outside admission and crossing the steam ports of the high-pressure cylinder an ingenious method of using a single valve stem and single ported valves was secured. In a compound engine the large clearances of the high pressure ports is not detrimental and this plan is simpler than those requiring a rocker to reverse the motion of the high-pressure valve or those requiring a double-ported valve on the low-pressure cylinder.

The piston rods and valve rods are continuous. To secure the high-pressure piston to the rod a nut is used instead of the key shown in the drawing. To remove the piston of the low-pressure cylinder, the high-pressure piston is removed by taking off the nut, and the back head of the large cylinder is taken down.

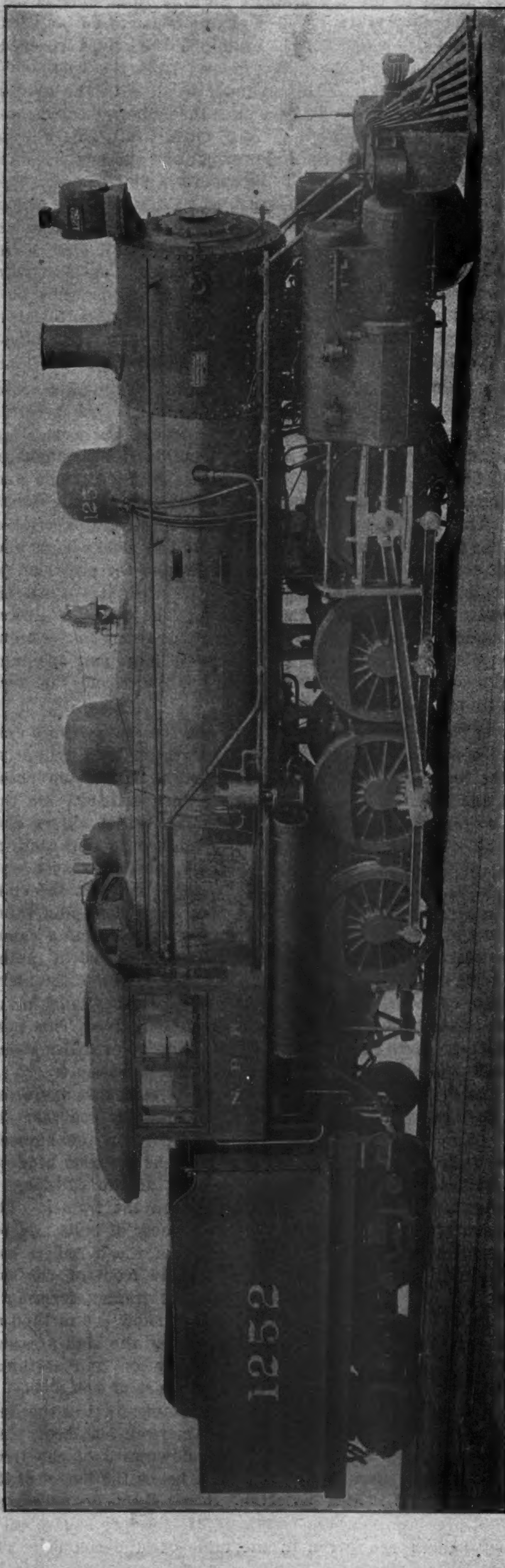
When access to the low-pressure packing rings only is desired the operation is simple. The engine is placed on the back center on the side which is to be examined, the guides loosened at the back end, and the nuts removed from the back low-pressure cylinder head. This cylinder head, with the guides attached, can then be shoved back until the cylinder head comes in contact with the forward driving wheel tire. This allows sufficient space to get at the follower bolts of the low-pressure piston and permits the rings to be examined or renewed. The back ends of the guides are fastened to a separate plate which is attached to the main guide yoke by four bolts. The back end of the guides is loosened by removing these four bolts and the lining of the guides is not disturbed. Comparatively little work is thus involved in examining the low-pressure piston beyond what would be required for the low-pressure piston of a two-cylinder compound, as neither the main rod, crosshead, or high-pressure piston need be disconnected.

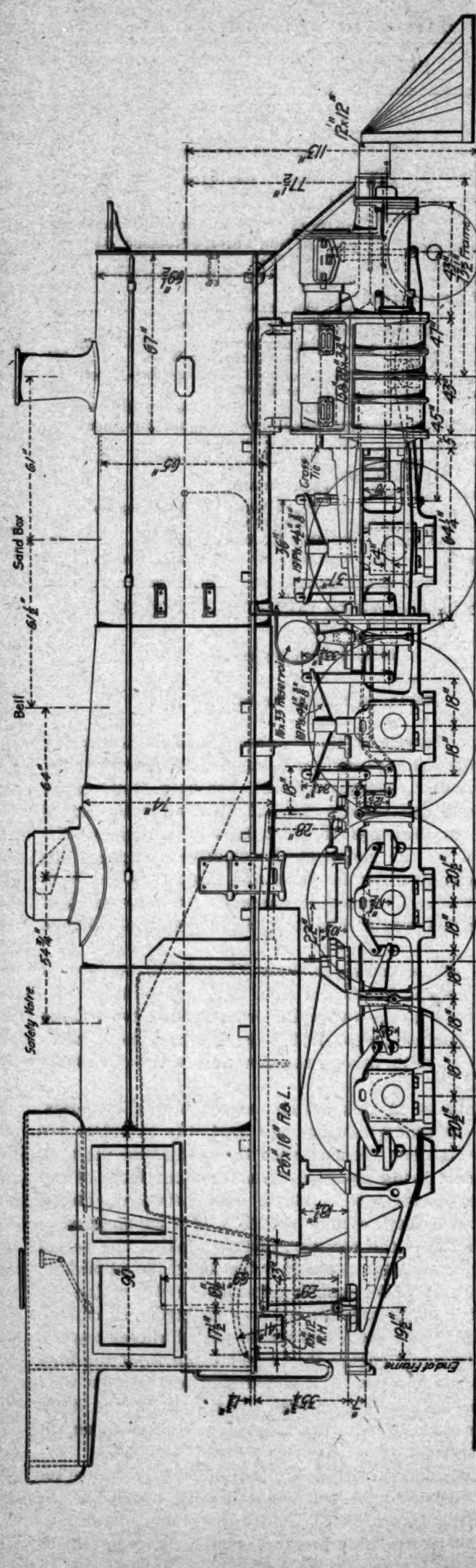
For packing the piston rods between the cylinders a close fitting sleeve with water grooves is used. It has a collar with ground joints fitting loosely enough between the head and the gland to take sufficient motion to accommodate the piston rod and provide for the wear of the pistons and cylinders. There is no removable or adjustable packing whatever. This idea was taken from years of successful experience with the same device in steam pumps. As this sleeve floats and has no work to do it ought to wear well, and the provision of the motion should prevent all difficulties with it. A special lubricator is provided for this bearing. The collar is always held against the head by the pressure of the steam in the high-pressure cylinder. It will be seen that very large port openings are provided, the high-pressure valve is short and the low-pressure clearances are very small.

Relief valves are used on the high and the low-pressure cylinders because of the use of piston valves on both cylinders. On the low-pressure these are attached to the steam chest itself and when open form a by-pass when drifting. On the side of the high-pressure steam chest the relief valves and starting valve are for convenience combined in one casting. These relief valves are closed when the throttle is open and when it is closed they open communication between the ends of this cylinder through the steam port. A simple plug valve working in a fore and aft direction serves as a starting valve. When starting the engine it is in the position shown in the engraving and admits steam to the exhausting side of the high-pressure cylinder, while the steam side of this cylinder takes steam through the throttle and main piston valve. This puts the high-pressure piston in equilibrium and gives boiler steam to the low-pressure piston at properly reduced pressure.

In the drawing of the frames it will be seen that there are two bars at the saddle which are brought together in front of it and both extend in a long splice to the bumper. Back of the cylinders cast-steel filling blocks are used between the frame splices and immediately back of the cylinders a substantial cross-tie is shrunk on between the frames. The character of the splices and the large number of bolts are, together with the security of the bolting of the cylinders and saddle, clearly shown in the drawing. In front of the cylinders a 1-in. plate is bolted between the frames, forming a substantial brace. The cylinder drawings show the method of conducting the steam pipe from the saddle to the high-pressure cylinder. This is also seen in the elevation and sectional views. The frames, except the front rails, are of cast steel.

In cross-section the firebox closely resembles that of the New York Central Atlantic type engines (American Engineer, February, 1901, page 37). With a slope downward of the front half of the mud ring a depth of 18 ins. below the barrel of the boiler is secured. Thick barrel and throat sheets are necessary, for the pressure on these boilers is 225 lbs. per square inch. These figures are given in the table of dimensions. The

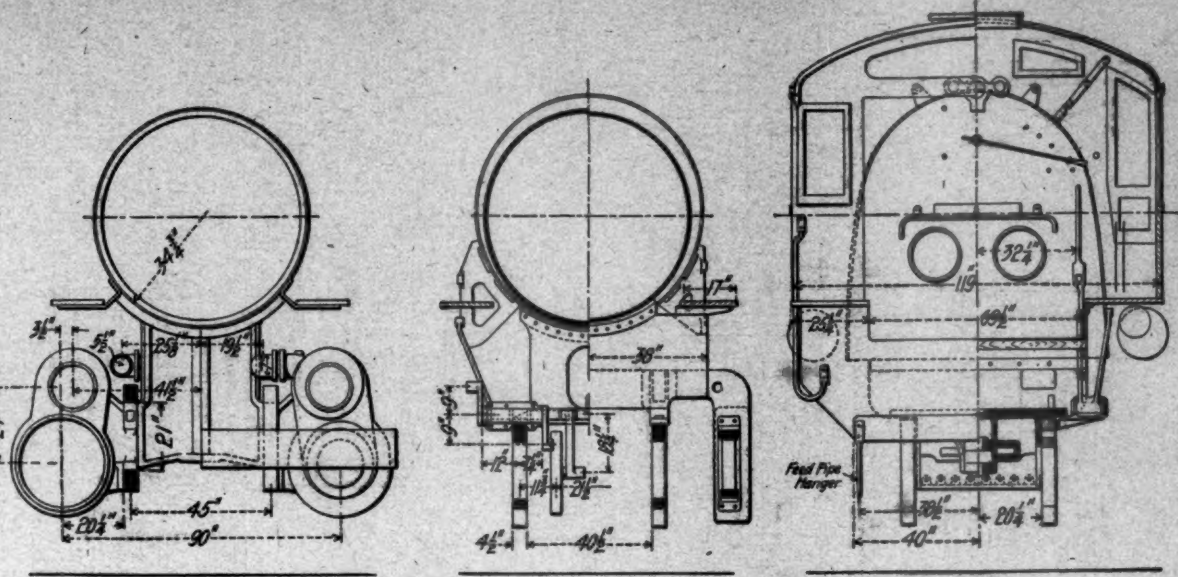




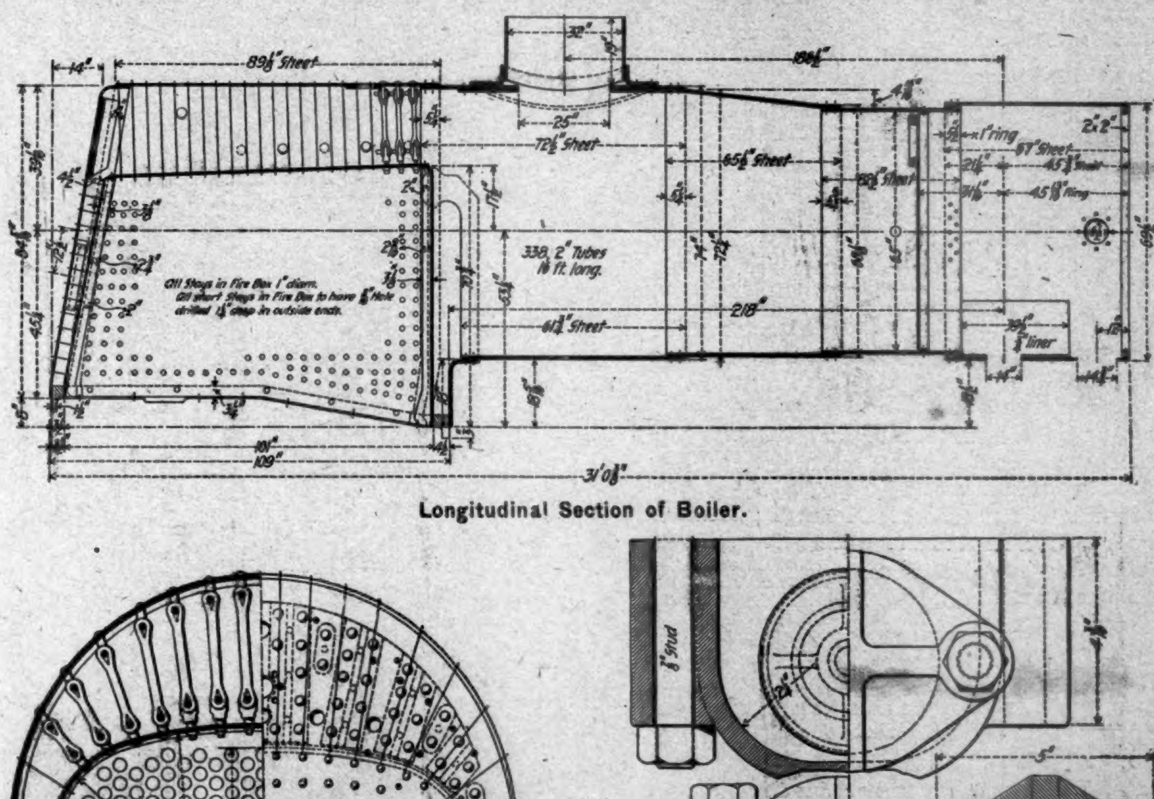
FOUR-CYLINDER TANDEM-COMPOUND CONSOLIDATION LOCOMOTIVE—NORTHERN PACIFIC RAILWAY.

A. LOVELL, *Superintendent of Motive Power.*

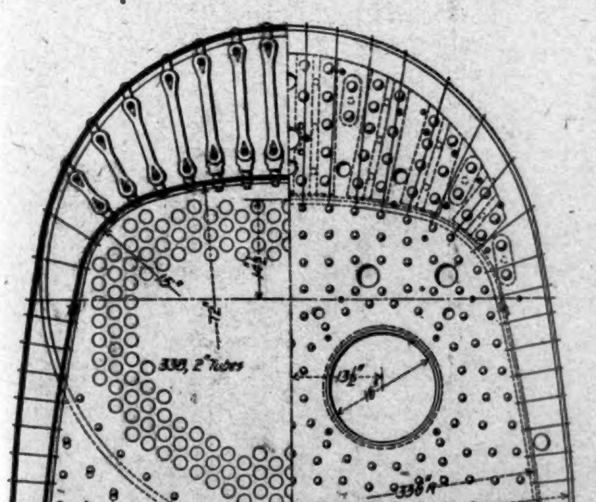
AMERICAN LOCOMOTIVE COMPANY, *Builders.*

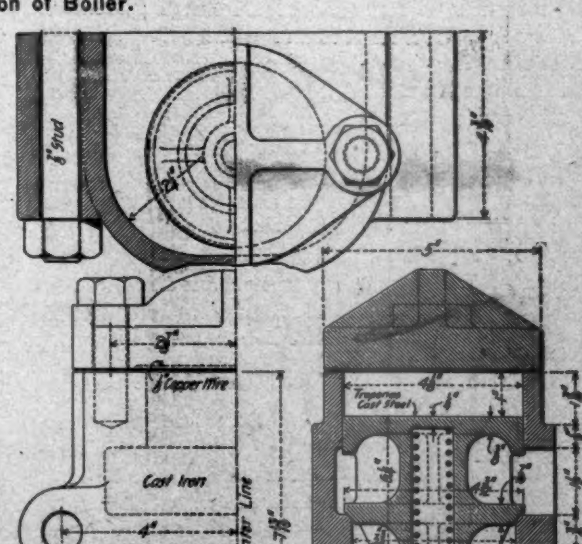


Half Rear and Front Elevations and Sections.



Longitudinal Section of Boiler.

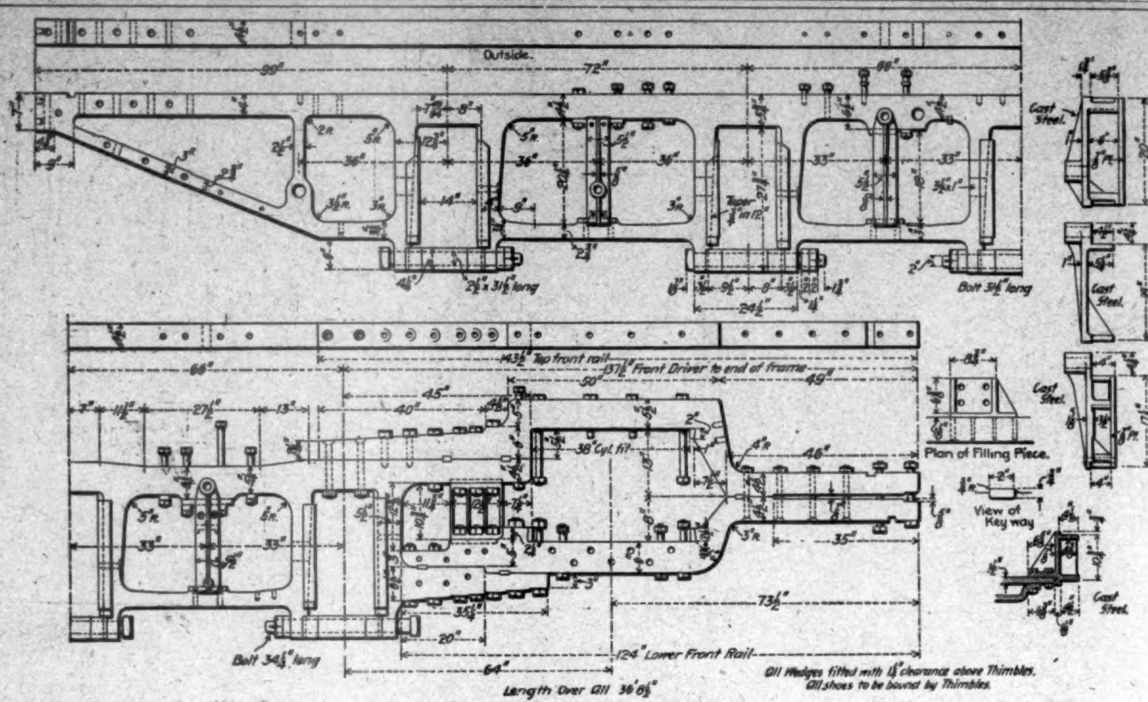




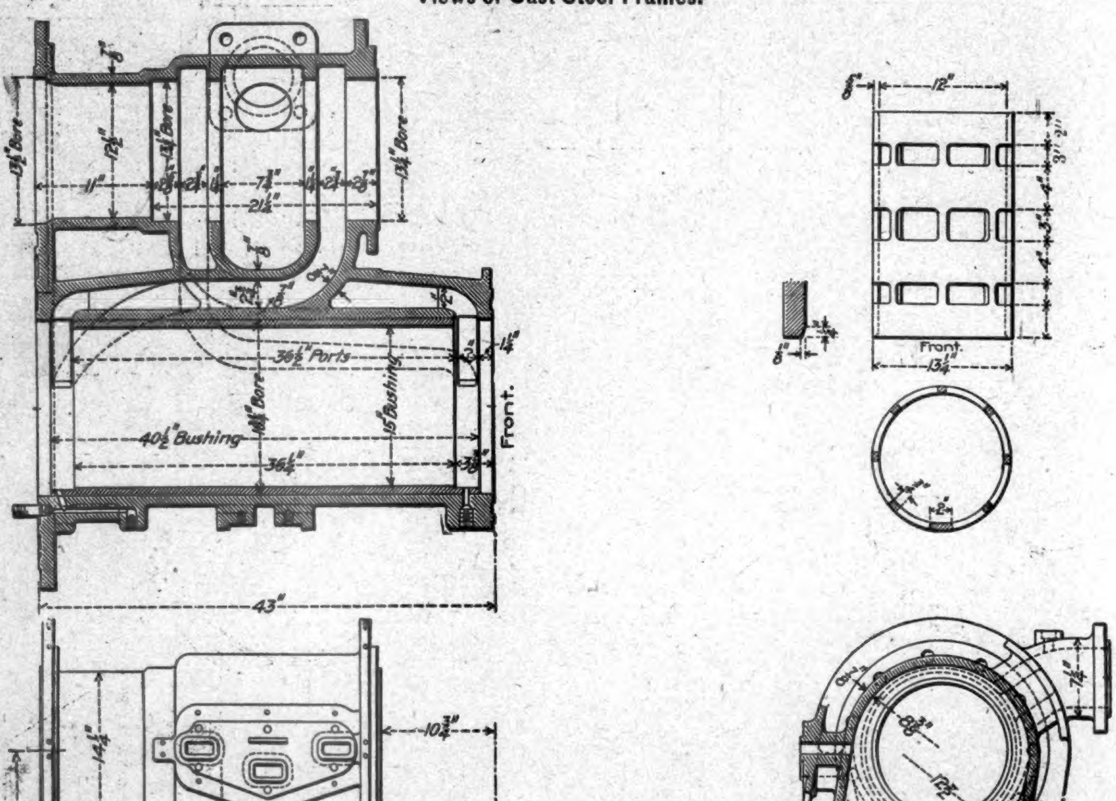
Transverse Section of Firebox.

Relief Valve for Low-Pressure Cylinder.

Four-Cylinder Tandem Compound Locomotive—Northern Pacific Railway.

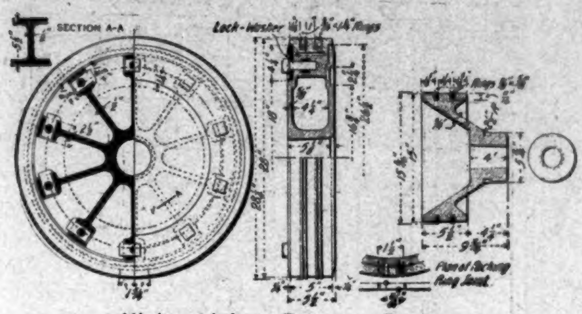


Views of Cast Steel Frames.

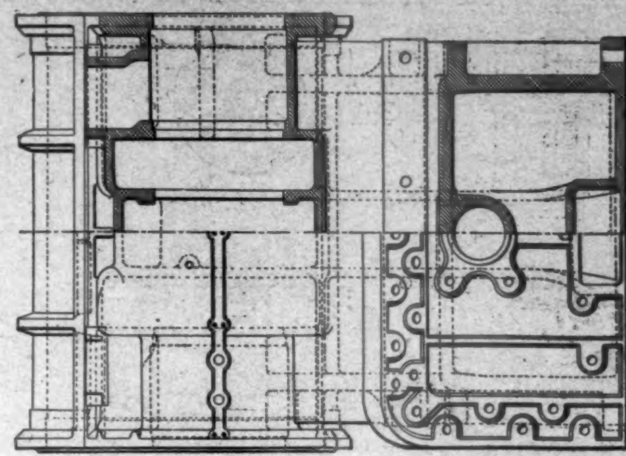


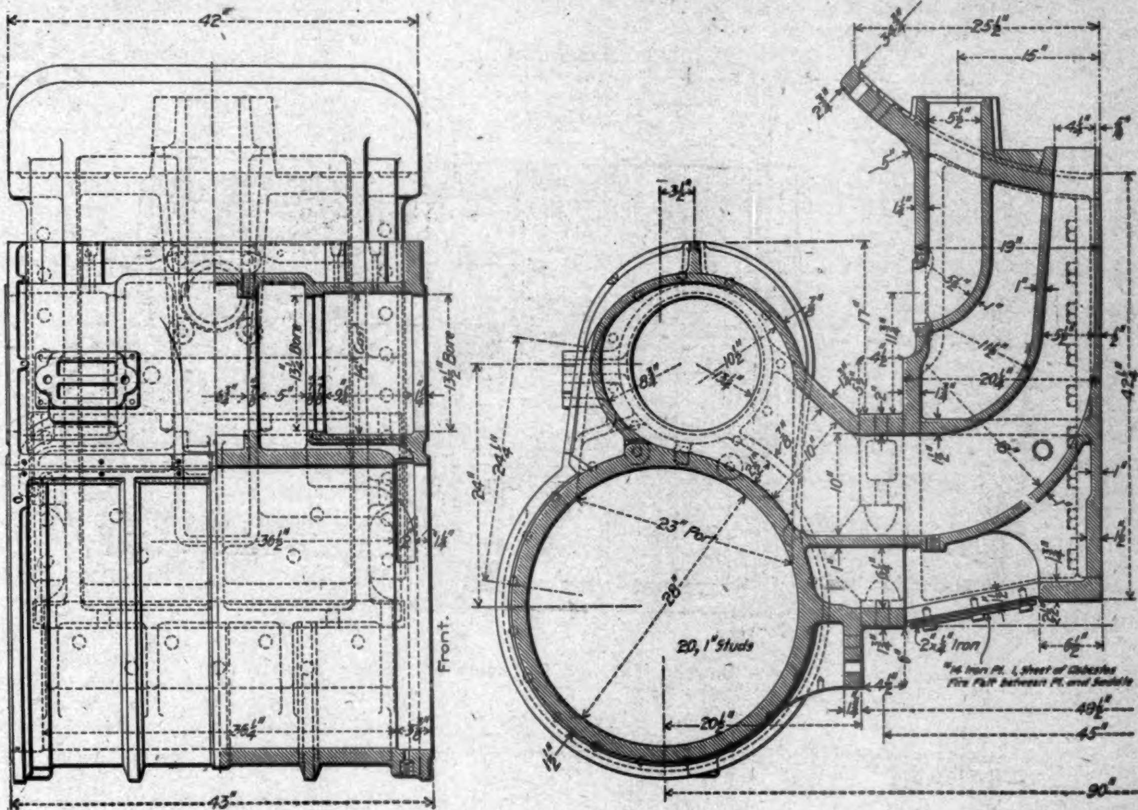
High Pressure Cylinder.

Four-Cylinder Tandem Compound Locomotive—Northern Pacific Railway.

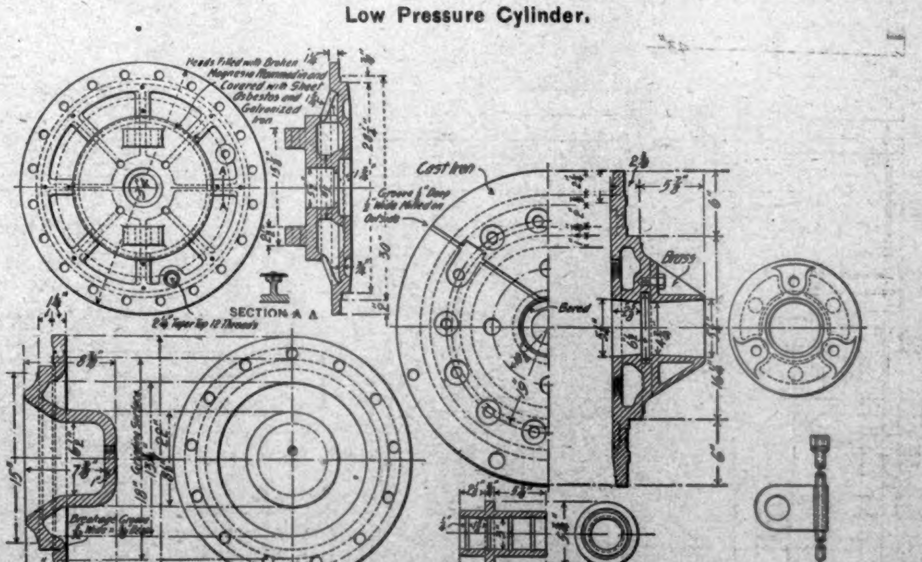


High and Low Pressure Pistons.



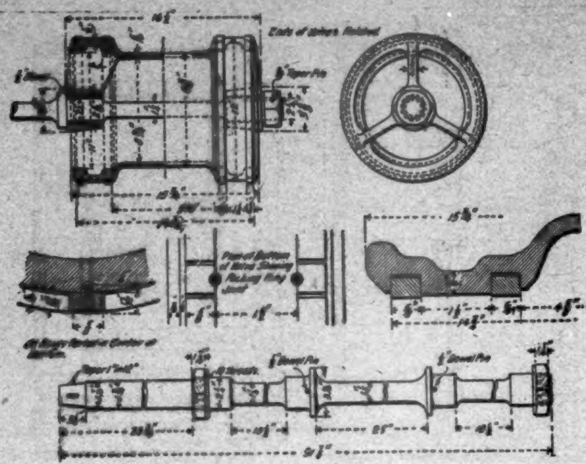


Low Pressure Cylinder.

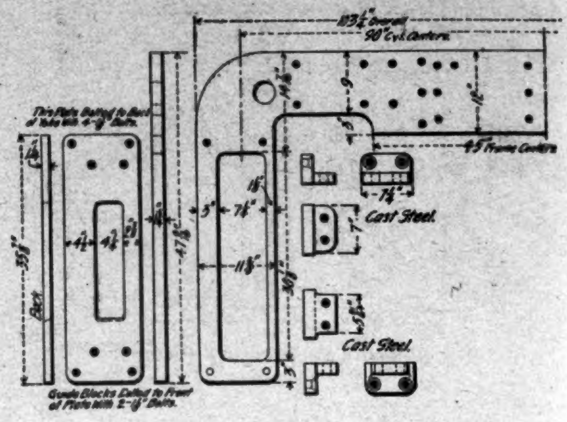


Cylinder Heads.

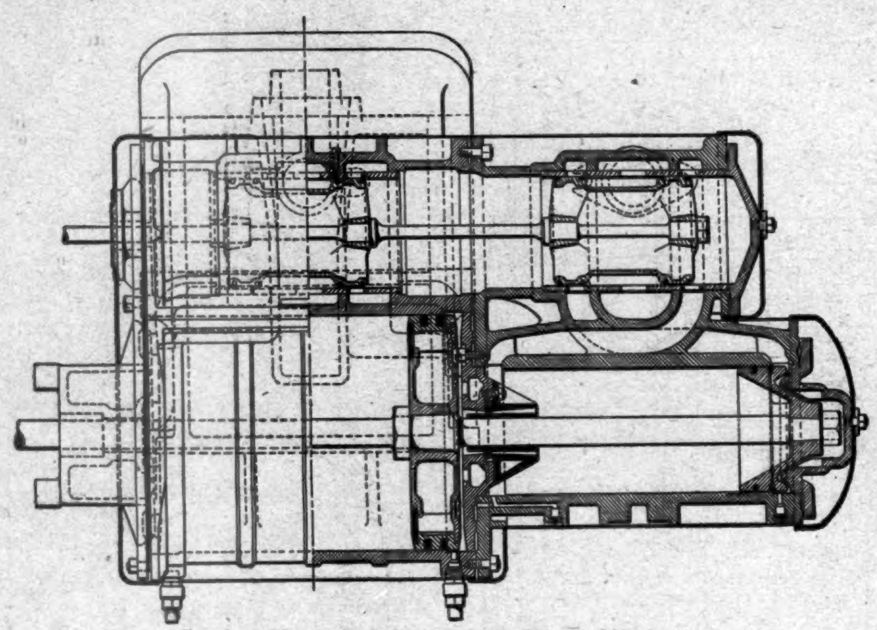
Four-Cylinder Tandem Compound Locomotive—Northern Pacific Railway.



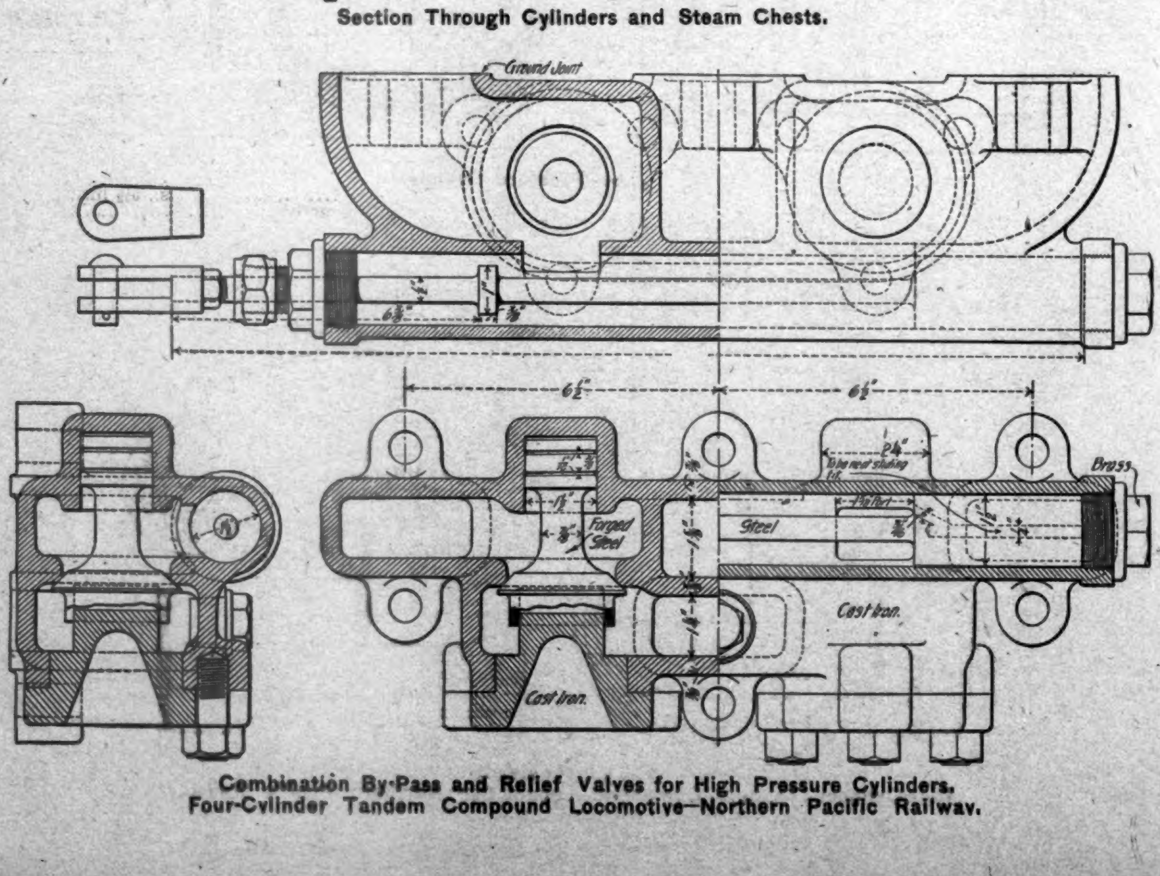
High Pressure Valve and Rod.



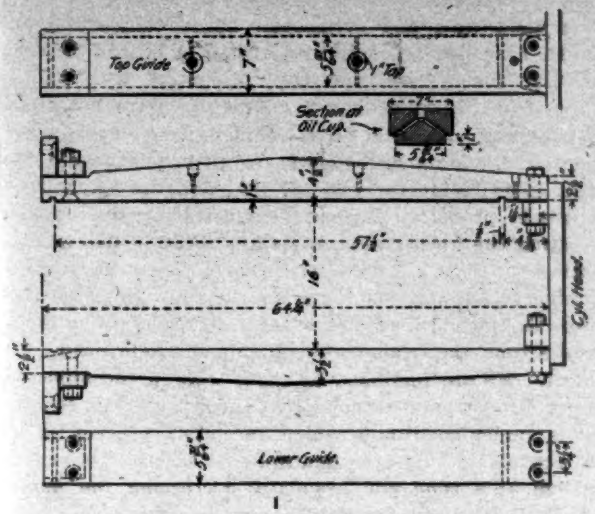
Guide Yoke.



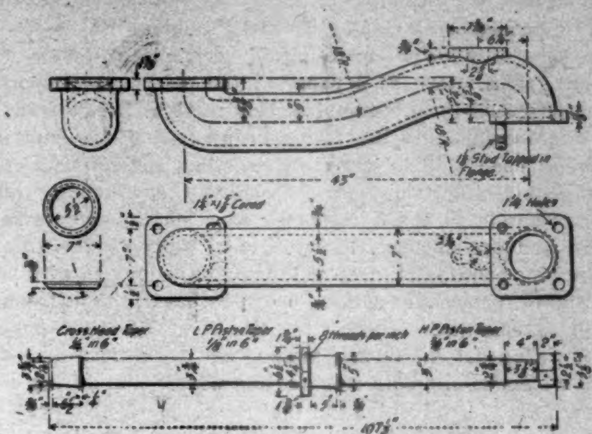
Section Through Cylinders and Steam Chests.



Combination By-Pass and Relief Valves for High Pressure Cylinders.
Four-Cylinder Tandem Compound Locomotive—Northern Pacific Railway.



Upper and Lower Guides.



Steam Pipe and Piston Rod.

boilers have two firedoors and sloping back heads. They are supported from the mud ring, as indicated in the elevation drawing.

From having followed this development in the drawing room and the shops it is evident that the greatest care has been exercised in the design of the details and before the type received the endorsement of the builders the experimental engine was put through the test of severe service, after which the present plans were prepared but without radical changes of any kind.

The valve motion gave the following measurements from engine No. 1,250 on the erecting floor of the Schenectady Locomotive Works, the uniformity of the cut-off and valve opening being specially noteworthy.

Valve Measurements.

No. of Notches.	Lead.		Valve opens.		Cut off.	
	Front stroke. Inches.	Back stroke. Inches.	Front stroke. Inches.	Back stroke. Inches.	Front stroke. Inches.	Back stroke. Inches.
1 Left	0	0	2 1/8	2 1/16	30 5/8	30 5/8
1 Right	0	0	2 1/8	2 1/16	30 5/8	30 1/8
2	3/16	3/16	15/16	15/16	25	25 1/8
3	7/32	7/32	25/32	25/32	23	23 9/16
4	1/4 S	1/4 S	11/16	11/16	21	21 1/8
5	1/4	1/4	5/8	5/8	19	19
6 Left	9/32	9/32	9/16 S	9/16	17	17
6 Right	9/32	9/32	9/16 S	9/16 S	17	17

The slip of the links in full forward motion is 1 5/16 in., in full back motion 1 1/16 in., and at half stroke 5/8 in. The valves are set line and line in both forward and back motions and the lead at 17-in. cut-off is 9/32 in.

Tandem Compound Locomotive, Northern Pacific Railway.

General Dimensions.

Gauge....4 ft. 8½ ins.
Fuel....Bituminous coal
Weight in working order....198,000 lbs.
Weight on drivers....175,000 lbs.
Wheel base, driving....17 ft.
Wheel base, rigid....17 ft.
Wheel base, total....25 ft. 9 ins.

Cylinders.

Diameter of cylinders....15 and 28 ins.
Stroke of piston....34 ins.
Horizontal thickness of piston....5¼ ins.
Diameter of piston rod....H. P., 3 ins.; L. P., 3¾ ins.
Kind of piston-rod packing....Cast iron

Valves.

Kind of slide valves....Piston type
Greatest travel of slide valves....6 ins.
Outside lap of slide valves....⅞ in.
Inside clearance of slide valves....H. P., ¼ in.; L. P., ⅝ in.
Lead of valves in full gear....Line and line F. & B., ¼-in. lead at ½-in. stroke cut-off.

Wheels, Etc.

Diameter of driving wheels outside of tire....63 ins.
Material of driving-wheel centers....Cast steel
Tire held by....Shrinkage
Driving-box material....Main, cast steel, I. F. & B. steeled cast iron
Diameter and length of driving journals....main, 9½ by 11 ins.; balance, 9 by 11 ins.
Diameter and length of main crank-pin journals....(Main side, 7¾ by 5¼ ins.) 6½ by 7 ins.
Diameter and length of side rod crank-pin journals, Intermediate, 5½ by 5 ins.; F. & B., 5 by 4¼ ins.
Engine truck, kind....Two-wheel, swing bolster
Engine truck journals....6 by 11 ins.
Diameter of engine truck wheels....33 ins.
Kind of engine truck wheels....Boies steel tired

Boiler.

Style....Extended wagon top with wide firebox
Outside diameter of first ring....66½ ins.
Working pressure....225 lbs.
Material of barrel and outside of firebox....Worth basic steel
Thickness of plates in barrel and outside of firebox, 9/16 in., ⅝ in., 13/16 in. and ⅞ in.
Horizontal seams....Butt joint, sextuple riveted, with well strip inside and outside
Circumferential seams....Double riveted
Firebox, length....100 1/16 ins.
Firebox, width....75¼ ins.
Firebox, depth....F, 70¾ ins.; B., 59¾ ins.
Firebox, material....Carbon acid steel
Firebox plates, thickness....Sides, ⅜ in.; back, ⅜ in.; crown, 7/16 in.; tube sheet, 9/16 in.
Firebox, water space....Front, 4½ ins.; sides, 3½ to 6 ins.; back, 3½ to 4½ ins.
Firebox, crown staying....Radial, 1⅛ ins. diameter
Firebox, staybolts....Taylor iron, 1 in.
Tubes, material....Charcoal iron No. 12
Tubes, number of....338
Tubes, diameter....2 ins.
Tubes, length over tube sheets....16 ft.
Fire brick, supported on....Water tubes
Heating surface, tubes....2,815.03 sq. ft.
Heating surface, water tubes....26.43 sq. ft.
Heating surface, firebox....155.64 sq. ft.
Heating surface, total....2,997.10 sq. ft.
Grate surface....52.29 sq. ft.
Grate, style....Rocking
Ash pan, style....Hopper, with slides operated by steam cylinder dampers front and back
Exhaust pipes....Single
Exhaust nozzles....5¼ ins., 5½ ins., 5¾ ins. diameter
Smoke stack, inside diameter....18½ and 16 ins.
Smoke stack, top above rail....15 ft. ¼ in.
Boiler supplied by....Two Hancock inspirators, Type "A," No. 10

Tender.

Weight, empty....47,000 lbs.
Wheels, number of....8
Wheels, diameter....33 ins.
Journals, diameter and length....5 by 9 ins.
Wheel base....15 ft. 8 ins.
Tender frame....10-in. steel channels
Tender trucks....Two trucks 4-wheel center-bearing double I-beam bolster
Water capacity....Tank water bottom of 5,500 U. S. gals.
Coal capacity....10 tons
Total wheel base of engine and tender....53 ft. 10½ ins.
Brakes....Westinghouse-American combined on drivers, tender and for train
Air pumps....Two 9½-in., with duplex governors
Water brake on cylinders....Le Chatelier
Safety valves....Three 3-in. Ashton special open pop
Blow-off cock....Little Giant
Lubricators....Michigan, 1 double and 1 triple
Sand blast....Leach D-2 double
Sectional lagging....Magnesia
Steam gauge....Ashcroft
Bell ringer....Western

The Chicago & Northwestern annual report shows that in the year ending May 31, 1901, 3,701 million tons of freight were hauled with a smaller train mileage than that of 1894 when 1,989 million tons were hauled. In seven years the train load has increased from 123 tons to 232 tons. The earnings per train mile now average $1.98 as against $1.33 in 1894, but the rate has decreased from 1.07 cent to 0.85 cent in that time.

The arrangement employed in the General Electric works at Schenectady for blue-printing by electric light was described by Mr. H. G. Reist in a paper at the recent meeting of the American Society of Mechanical Engineers at Milwaukee. The carriages supporting the blue-printing frames are run under a metal hood a little larger in size than the printing frame, each containing two 5-ampere, 110-volt enclosed-arc lamps. The lamps in turn are supported on a small trolley arrangement and are enclosed in white opal globes. The time required for printing is three or four times as long as with bright sunlight. The cost of making prints by electric light is smaller than by sunlight, owing to the fact that the labor employed in carrying out the former method can be utilized during the entire office hours, both summer and winter, and during cloudy days. Another advantage is that with the electric equipment blue prints may be put into the shop almost immediately after the completion of the tracing, regardless of the time of day.

The gross earnings of all the railroads in the United States reporting to R. G. Dun & Co. for July are $50,732,912, a gain of 13.2 per cent. over last year and 25.2 per cent. over 1899. The increase continues remarkably large. Southwestern roads are still in the lead, but on all other classes earnings show a very uniform percentage of gain. The statement includes many leading systems and about one-half the total mileage of the country. It indicates a prosperous condition for the railroads and the country as well, for it shows a volume of business in all leading classes of freights greater than ever before known at this season.

In considering the introduction of a special engine for driving the fan of a heating apparatus in connection with the blower system of ventilation and heating, it should be clearly realized that a certain amount of steam being required for supply to the heater, the passage of that steam through the engine on its way to the heater entails very little loss in its heating power—so little, in fact, that the actual expense of driving the fan may be disregarded and the steam-engine cylinder may be looked upon as merely an enlargement of the steam pipe. Evidently this feature of this system has its influence on the relative cost of driving the fan by an engine or by an electric motor, for, in the employment of the latter there is no incidental return whereby the cost of power is reduced.

"Technolexicon" is the name decided upon for the trilingual technical dictionary, the compilation of which has been undertaken by the "Verein Deutscher Ingenieure." This work will be printed in English, German and French, and in three volumes, for the convenience of those who best understand only one of these languages. Appeals for co-operation have been issued, assistance being necessary from those who are familiar with the needs of various interests who will be benefited by the dictionary. All the expense of publication is to be borne by the German society acting disinterestedly, to meet the long-felt need for a satisfactory authority on technical terms. This movement is heartily commended. A dictionary of this kind will increase in value with the growing tendency toward international trade in engineering products. Its usefulness is not confined to scientists, for it is probably most needed by those who find it necessary to impart knowledge of their productions to those who think, write and talk in other languages, in which technical terms find no logical equivalent. Dr. Hubert Jansen, the editor-in-chief of the "Technolexicon," should receive the heartiest co-operation of those who need this work, and it appears to be the duty of the engineering societies to respond unreservedly. His headquarters are Dorotheenstr. 49, Berlin (N. W. 7), Germany, where all communications and contributions should be addressed.

The water-tube and cylindrical boiler controversy in the English navy led recently to a trial run of the "Hyacinth," with Bellville boilers, and the "Minerva," with cylindrical boilers, from Gibraltar home. The ships were not alike and the trial was, as should have been expected, inconclusive, although the honors are apparently given to the old type of boiler. The "Minerva" had 150 lbs., and the "Hyacinth" 250 lbs. steam pressure. Beyond demonstrating the possibilities of getting the former ship up to full speed in two hours after lighting the fires, together with the fact that her boilers and machinery gave no trouble during the run, while the Bellville boilers leaked and a fireman was scalded severely by the bursting of a tube, the trials threw no valuable light on the general subject. We are reminded by these tests of the numerous attempts to compare locomotives under "similar conditions," that is, under conditions which absolutely prevent an intelligent conclusion. By investigating one feature of a complicated problem at a time and gradually decreasing the number of unknown quantities an opinion may be formed. In this case the advocates of the water-tube boiler should defend the type from unjust condemnation because of these tests. Even if the tests had given conclusive results the case of the water-tube boiler is not weakened by a test of a boiler of this type which is not considered as a fair representative.

American locomotives on Indian railways are favorably reported upon by the Locomotive Superintendent of the Oudh & Rohilkhund Railway under date of May 17 and recorded in "Engineering News" as follows: For this road ten mogul locomotives, six wheels, coupled, with a Bisel truck, were built by the Baldwin Locomotive Works, and were delivered in May, 1900. At the end of April, 1901, these locomotives had recorded an average mileage of 23,070 miles. The only change made at first was in the grates, which did not suit Bengal coal; and new bars, with a ⅞-in. space between, were put in them. Later, certain oil-cups and the sandboxes were changed to suit Indian requirements. The chief defects pointed out by the superintendent are as follows: Eccentric sheaves came loose on axle in two engines, vacuum brake cylinder hangers of tender are put on with bolts and nuts so placed as to be impossible to get at with wrench, the nuts have to be tightened up nearly each trip; the engine-cab, while very roomy and comfortable, is not stayed sufficiently and rocks a good deal with the "constant jolting of the engine." All of these defects seem to result from a very rough track. The average coal consumption on the ten engines, from October, 1900, to March, 1901, was:

Per engine mile	48.29 lbs.
Per vehicle mile	1.92 lbs.

The new "B" class English engines do the same work as follows:

Per engine mile	45.25 lbs.
Per vehicle mile	1.94 lbs.

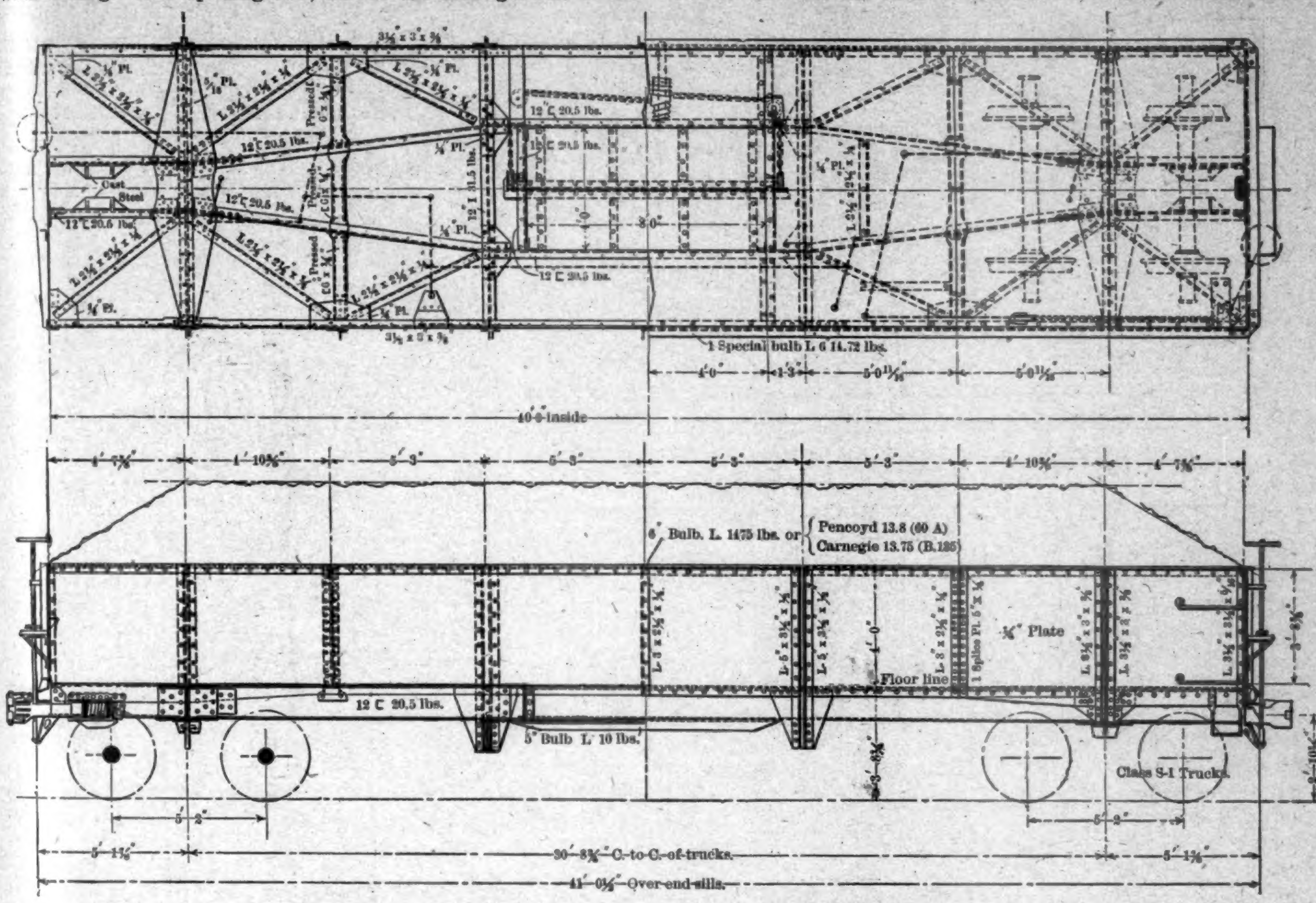
The cost of the American locomotives complete was $12,614 each, with the rupee = $0.32.4 each. Class "B" English locomotive cost $14,523. The report concludes as follows: These ten engines have been working passenger trains, running at 30 to 35 miles an hour, and goods trains running at 20 miles an hour, chiefly the former, and they have done their work well. They steam capitally, and are remarkably good starters; they get away from a station with 55 loaded goods wagons (equal to about 1,300 tons) with the greatest ease. They are a little higher in coal consumption than our new "B" class. They are easily repaired, but repairs will have to be kept up, if not, they will go to pieces sooner than another engine would. They do not, as far as I can see at present, cost more in repairs than other engines, and I am very well satisfied with them.

From the figures of coal consumption given above it will be noted that the coal used per engine mile by the American locomotive is slightly greater than that of the English engines, but when more fairly compared on the basis of coal per vehicle mile a saving of the difference between 1.94 and 1.92 is shown by the American locomotive.

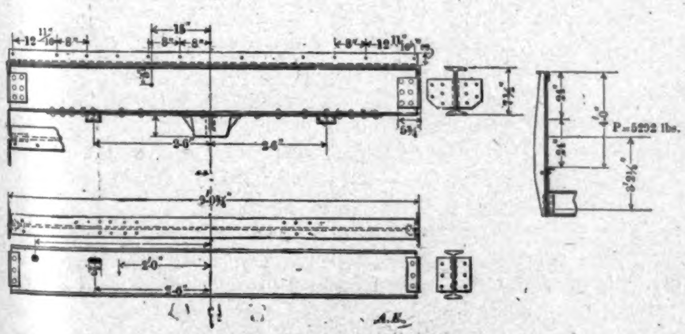
FIFTY-TON STEEL DROP-BOTTOM GONDOLAS.

Elgin, Joliet & Eastern Railroad.

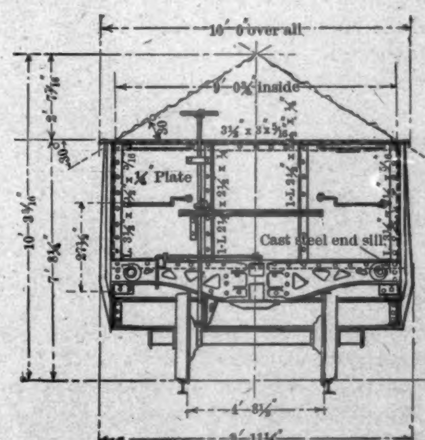
Through the courtesy of Mr. George I. King drawings of the new 50-ton gondola coal cars now building for the Elgin, Joliet & Eastern have been received. These cars have drop bottoms with a large door opening and, due to the arrangement of the underframe, the opening is at the center of the cars and has an area of 32 sq. ft. Instead of placing a pair of sills at the center of the car he has used an interesting composite structure which is a decided departure from previous designs. The center sills are 12 ins. 20.5 lbs. channels placed 4 ft. apart at the center of the car with their ends resting on 12-in. transverse floor beams of I-section placed 10 ft. 6 ins. apart. From these floor beams the center sills are extended by other 12-in. channels reaching as far as the body bolsters and drawn toward each other at these ends to meet the lines of the draft sills which are separate members secured at their outer ends to cast-steel end sills and at the inner ends to the bolsters. At the body bolsters, which are 12-in. I-beams, the center sills are secured by bent plates riveted to the bolsters and to the sills. The sills are not continuous and the body bolsters are not cut for the sills; they extend across the car and are reinforced by large cover plates. Instead of using heavy side sills Mr. King has employed the sides as plate girders to assist in carrying the load and the manner of carrying out the construction indicates very careful study, which is apparent in the light weight of the car. At the ends of the central sections of the center



New Fifty-Ton Gondola Coal Car—Elgin, Joliet & Eastern Railroad.

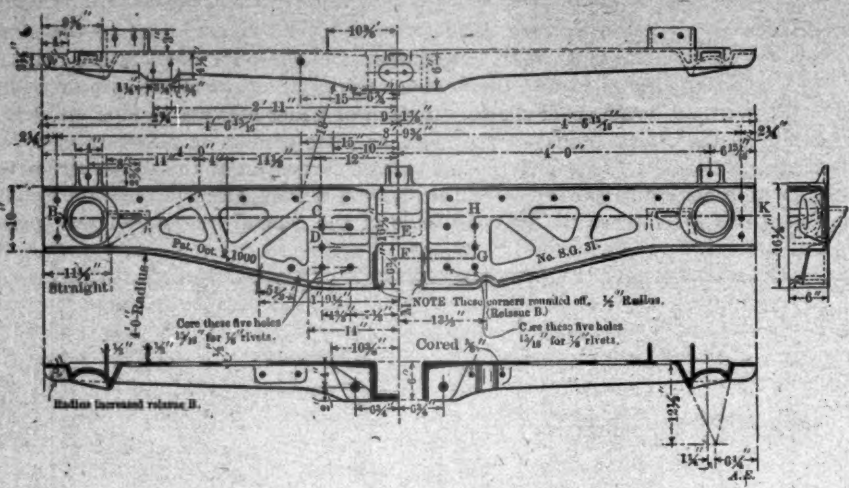


Transoms and Floor Beams.



End Elevation.

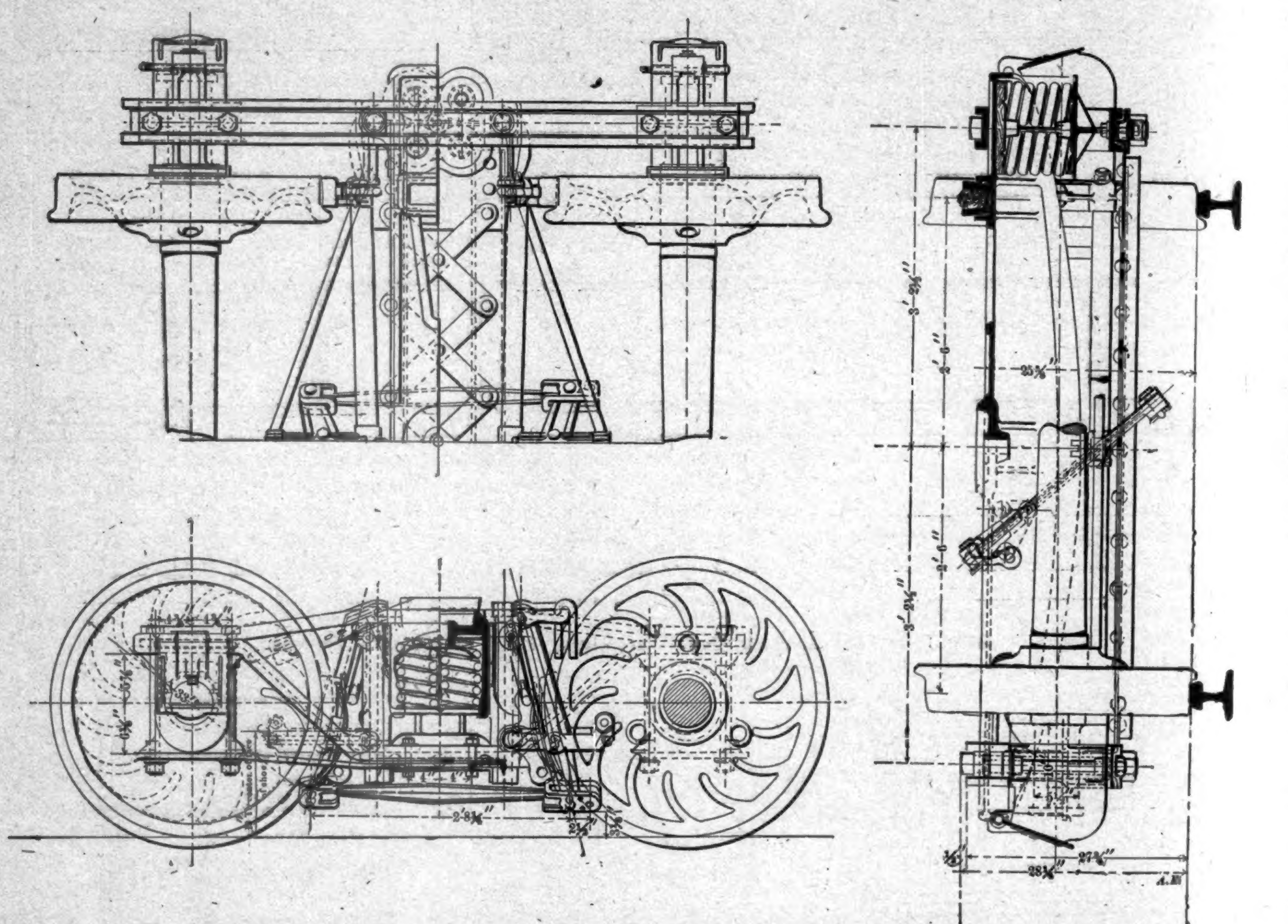
sills the load is transferred to the sides by the transverse I-beams and these are secured to the side trusses by plates and double angles which are also stiffeners. At the top of the sides a special 6-in. bulb angle is used. The only departure from commercial sections discovered from the drawings are pressed channel floor supports midway between the heavy transverse I-beams and the bolsters. These were used apparently to avoid cutting the channels. Additional floor support is obtained from



Showing Construction of Cast-Steel End Sill.

figures from the stress diagrams have nearly all been reproduced. This is Mr. King's customary practice. For convenience the leading dimensions are stated in tabular form.

The trucks for this car represent a successful type of heavy construction of the arch bar form. They have cast-steel bolsters, and spring planks of 4-in. channel section with lattice lining. The end castings are of cast steel, the journal boxes of malleable iron and the "National Hollow Brake Beam" is used. A special 5-in. channel section is employed for the arch bars, the flanges of which are 1 in. thick. A pair of these trucks complete weigh 14,400 lbs., of which the wheels and axles contribute 8,400 lbs.



Truck for Fifty-Ton Gondola Coal Cars.—Elgin, Joliet & Eastern Railroad.

the unusually large number of diagonal bracing angles secured at their ends to gusset plates.

It is regretted that the drawings cannot be shown complete. They convey an impression of engineering applied to car construction which has thus far been given to very few designs. Instead of the general plan the stress diagram has been selected for illustration as it presents the idea of the construction more clearly. In the engraving an effort was made to render explanation in detail unnecessary. Attention should be directed to the increased depth of the side plating at the ends of the car where it seems likely that more metal is required than at other portions because of the absence of side sills. In order to put on record the method of determining the sections of the various important members and to show how much these sections exceed those theoretically necessary the

General Dimensions.

Capacity, level full	1,490 cu. ft.
Capacity, top of 30 deg. heap	1,927 cu. ft.
Capacity, nominal	100,000 lbs.
Capacity, rated	110,000 lbs.
Capacity, maximum	120,000 lbs.
Maximum load coal at 52 lbs. per cu. ft.	100,200 lbs.
Weight complete, estimated	37,000 lbs.
Dead weight per cu. ft. 30 deg. heap	19.2 lbs.
Dead weight, per cent. of total	25.2
Paying weight, per cent. of total	74.8
Length over end sills	41 ft. ½ in.
Length inside	40 ft.
Width over all	10 ft.
Width inside	9 ft. ¾ in.
Height of floor above rail	3 ft. 8¼ ins.
Height over sides	7 ft. 8¼ ins.
Height top of 30 deg. heap	10 ft. 7 7/16 ins.
Height of side	4 ft.
Center to center of trucks	30 ft. 8¾ ins.
Wheel base of trucks	5 ft. 2 ins.
Door opening area	32 sq. ft.
Truck journals	5½ by 10 ins.
Diameter of wheels	33 ins.
Weight of wheels, each	640 lbs.

From the Stress Diagram.

Assumed Loading.

Base dead load	32,000 lbs.
Maximum live load	120,000 lbs.
Weight of trucks	14,400 lbs.
Deduct weight of wheels and axles	8,400 lbs.
Weight of truck materials above axles	6,000 lbs.
Gross body dead load (32,000 — 6,000)	26,000 lbs.
Deduct for bolsters, etc	13,000 lbs.
Net body dead load	24,700 lbs.
Assumed live load	120,000 lbs.
Total static body load	144,700 lbs.
Add 50 per cent., or	72,350 lbs.
Final uniformly distributed load	217,050 lbs.
Ditto per sq. ft. floor area	595 lbs.
Total floor area	362.5 sq. ft.

Side Pressure and Side Sheet Ties.

Area of unsupported side (4 ft. by 10 ft. 6 ins.)	42 sq. ft.
Weight of 1 cu. ft. water	63 lbs.
Pressure "P," (see section) 63 × 42 × 2	5,292 lbs.
Stress in (2) connection tie bolts $\frac{5{,}292 \times 38.125}{20.125}$ =	10,025 lbs.

Main Side Stiffeners.

Resultant pressure one set stiffeners	5,292 lbs.
Max. bending moment at tie connection (5,292 × 18)	95,256 lbs.
Section required at 16,400 lbs. per sq. in	5.1 sq. ins.
Two angles 5 by 3½ by ½ ins	5.98 sq. ins.

Center Sills.

Maximum moment	44,966 ft.-lbs.
Section required at 16,400 lbs. per sq. in	32.8 sq. ins.
Two 12-in. channels (20.5 lbs)	42.8 sq. ins.

Sides.

Maximum moment	82,362 ft.-lbs.
Maximum moment from concentration	148,536 ft.-lbs.
Total maximum moment	230,898 ft.-lbs.
Flange stress	57,724 lbs.

Bottom Flange.

Net area required (at 16,400 lbs.)	3.41 sq. ins.
Total net area web and angles	3.7 sq. ins.

Top Flange.

Flange stress as before	57,724 ft.-lbs.
Area required (at 11,000 lbs. per sq. in.)	5.2 sq. ins.
One-sixth of net web area	1.66 sq. ins.
Special bulb angle	4.3 sq. ins.
Total area provided	5.96 sq. ins.

Bolster.

Static load at end plus 100 per cent	50,666 lbs.
Section required (at 15,000 lbs.)	118 sq. ins.
Section provided	109 sq. ins.
Rivets ¾-in. in diameter required	18

Floor Beams.

Maximum moment (one beam)	43,000 ft.-lbs.
Section required	31.5 sq. ins.
Section provided (1, 12-in. 40-lb. I-beam)	36 sq. ins.

Signals from a 30-in. searchlight, on the electric tower of the Pan-American Exposition, were sent to Niagara Falls, July 25, by Prof. Geo. F. Sever, Superintendent of Electrical Exhibits, in the presence of the electrical jury, thus demonstrating the feasibility of this method of signalling at night. Since that time searchlight signals have been sent from Buffalo to Toronto, a distance of 58 miles, through arrangements completed by Prof. Sever in co-operation with Mr. Wm. S. Aldrich, Consulting Electrical Engineer of Toronto. The first trial was made 9.10 p.m., August 9, with clouds over Toronto. The local illumination of the overhead sky by the electric arc lights in the streets of Toronto effectually prevented any discrimination being made between the local and the Buffalo illumination of the clouds. The second trial was made August 13, with a perfectly clear atmosphere. Owing to the smoke settling down over the city, no signals could be discerned from the top of the Municipal Hall tower, Toronto. This was the prearranged objective point for both experiments. Special long-distance communication was arranged between the top of the tower and the electric tower, at the Pan-American, through the courtesy of the Bell Telephone Co., represented by Mr. Dunstan, of Toronto, so that every detail of the experiment could be followed. The special instructions were to depress the searchlight to the lake horizon, bearing on the Municipal Hall tower, Toronto; then, to sweep the horizon a definite angle, to the right and left of this bearing, and later to elevate and depress the light on the original bearing. All of these signals were very clearly discerned during the second trial by Mr. C. H. Rust, City Engineer, Toronto, with a party located on Centre Island, two miles off shore from the city.

SOME PHASES OF THE WATER-TREATING PROBLEM.

SECOND PAPER.*

By Howard Stillman, Mem. A. S. M. E.

Engineer of Tests, Southern Pacific Company.

The forced evaporation demanded of the locomotive boiler in modern railway service may be shown in many ways. An illustration of this in comparison with the same boilers had they been in stationary service may be shown from the following figures taken from locomotive service tests, which are presented simply for the purpose of showing the rate of evaporation in point of time.

Five tests at random from a series are taken covering train service under different conditions and for stationary practice. I am supposing the usual builders' rating of 30 pounds water per horse-power per hour to express the builders' rating, supposing, as we may imagine, that the boilers had effected the same rate of evaporation as if set up in stationary service instead of actual road service.

Test number	1	2	3	4	5
Size of cylinders of locomotives	Simple. 22 × 26	Compound. 23 + 35 × 32	Simple. 20 × 28	Simple. 20 × 24	Compound. 23 + 35 × 34
Service	Freight	Freight	Freight	Pass'g'r	Freight
Distance covered in the test, miles	239	136	329	171	196
Actual running time.	16.2 hrs	8.9 hrs	16.9 hrs	5.3 hrs	24.3 hrs
Total pounds water evaporated.	187,038	122,482	187,888	79,063	285,466
Ditto per hour.	11,545	13,760	11,060	14,918	11,748
Capacity developed by above boilers at (stationary) builders' rating of 30 lbs. water per horse power hour:					
Horse power of boiler	385	458	386	497	392

In other words, the rating of the boiler in test number one would have developed 385 horse-power if in stationary practice the rate of evaporation had been as shown. During the above test the cylinders were indicated and an average of records under full working conditions developed the following work being done by steam cylinders:

Test number	1	2	3	4	5
Mean I. H. P. full working	1,141	1,090	1,017	998	1,130

An average of these figures shows that the locomotive boilers in road service were at times forced in the rate of evaporation 126 per cent. above what we would consider their normal "static" rating. Nor is this all, as the total amount of water evaporated as above shown includes air pump, steam brake, blower and other work demanded in service, an amount comparatively small, however, as compared with the work of the steam cylinders.

It was my endeavor in the former paper to show that boiler waters containing considerable alkali matter (Glauber's salt and common salt) tend to prime and foam where in stationary service such waters would not cause trouble, such being one phase of the water-treating problem as applied to railway service. The forced evaporation of say 126 per cent. above stationary practice may show why such condition occurs, coupled with another consideration as follows:

We find in our most modern locomotive that the lower steam throttle opening is but 26 ins. above the water level when the gauge glass is half full and the engine on level track. The diameter of the boiler shell is 75 ins., and ample steam room is apparently provided, but the tendency to carry water over into the steam cylinders when the throttle opening is so close to the water line is most apparent. In stationary practice and boiler setting we generally find a steam drum and attachments well above the boiler shell, but the modern locomotive boiler has not room for such a device. The above considerations appear to me to largely account for the difficulty ex-

*See American Engineer, June, 1901, page 184.

perienced with foaming in locomotive boilers, and it is questionable if we had not better limit the introduction of alkali to correct the scale formation to the least amount. In my former paper I ventured a commercial limit of 30 grains per gallon (say 4½) lbs. per 1,000 gallons), beyond which amount naturally contained, plus the reaction from chemical treatment, the profit from scale prevention is offset by a tendency to prime, the worst feature in the use of alkali water on railroads. The working disadvantages and heat losses from this cause are too well known to require discussion here.

Very interesting and exhaustive experiments have been made at Purdue University (also presented to the American Society of Mechanical Engineers) with the calorimeter to determine quality of steam furnished locomotive cylinders as to entrained water. More than 1½ per cent. moisture was not observed, but unfortunately the quality of the water from which steam was furnished was not an element of the investigation. It is doubtful if conditions other than favorable, as to dome and throttle setting relative to the water line were maintained during the tests. Exceptional conditions are most likely to occur in main line service, and a series of investigations in this direction on alkali water would be most interesting, and in all probability would show results of widely varying nature f om those obtained.

The use of some form of steam separator would be suggested were it possible to apply it to the locomotive. Some modification of throttle whereby the openings are raised to the highest possible position above the water line seems the more feasible. There are few locomotive engineers who do not recall in their experience certain engines they have handled that carried their water better than others. The difference can always be traced to the principle referred to—that a difference in boiler construction or cylinder ratio to steam space had favored the relation between supply and demand in one case more than another.

The condition or quietude, as we may express it, of a boiling mass of water within a steam boiler varies directly as the drain upon its mass. The greatest production of steam is always from the hottest portion of the mass, or adjacent to the firebox plates, and we must expect violent ebullition in direct proportion to the demand. That the amount or degree of disturbance is again directly proportionate to the solid matter within the boiler water (soluble or insoluble) we are very sure. I have seen instances in a boiler carrying bad alkali water where the water would leave the gauge glass entirely on opening the throttle to pull out with a heavy train. Evidently the boiling mass tended to follow the direction of a drain on its evaporative capacity, the steam dome in such case having been placed well ahead on the boiler. After starting the train the closing of the throttle for a few seconds will bring the water again to its level. The practice in such districts when water gets very bad is for the engineer to occasionally close the throttle and verify the water line. No detail of his routine is of more vital importance to the engineer or of more anxious concern to him than the location of the water line.

This is a digression from the subject in hand, but I have referred to it as of great importance as a side issue to the excessive use of alkali (carbonated or in other form) to remove scale.

To what extent scale deposits affect the loss of fuel is a disputed question, and there have been so many widely different statements made that we have little of value except general principles to depend on. Any series of tests to determine the effect of the scale in heat losses must be particularly rigid in having similar conditions, eliminating all variation in condition except the scale itself. In practice absolutely uniform conditions are extremely difficult to obtain. It will be understood that I am referring to railway service. In stationary practice it is much easier to arrive at definite conclusions as between cause and effect.

As far as I have been able to observe from conducting many boiler tests, I do not believe that a light scale formation, say not to exceed 1-16 in., has any material effect on fuel losses.

In the stationary boiler using continually the same water the scale formation will continue to increase and should be kept out. In the locomotive boiler the formation from one source may be offset or removed by water from another source. The effect of alkali on a boiler that has been scaled from use of hard water is generally disastrous. We have abundant evidence that alkali water tends to open seams and causes flues to leak, where previous scale formation had mechanically closed them. Soluble matter in a boiler is very penetrating and follows the water in all cases, hence we find the deposit from evaporated leakage on the outside of a boiler about leaking seams or staybolts, also the penetration and flaking off of old scale within the boiler.

From tests made on scaled boilers, I believe that very hard sulphate scale is less to be feared than loose carbonated scale, both in the danger from sudden removal in service and from its heat-conducting capacity, which is greater in proportion to its hardness.

The variations produced by the "migratory" nature of the locomotive boiler is a peculiar phase of the water problem, and that is so largely local that it can hardly be solved by general conclusions. A change of water affects boilers much as the human system is affected by a change of diet, and what is good for one condition may be bad for another.

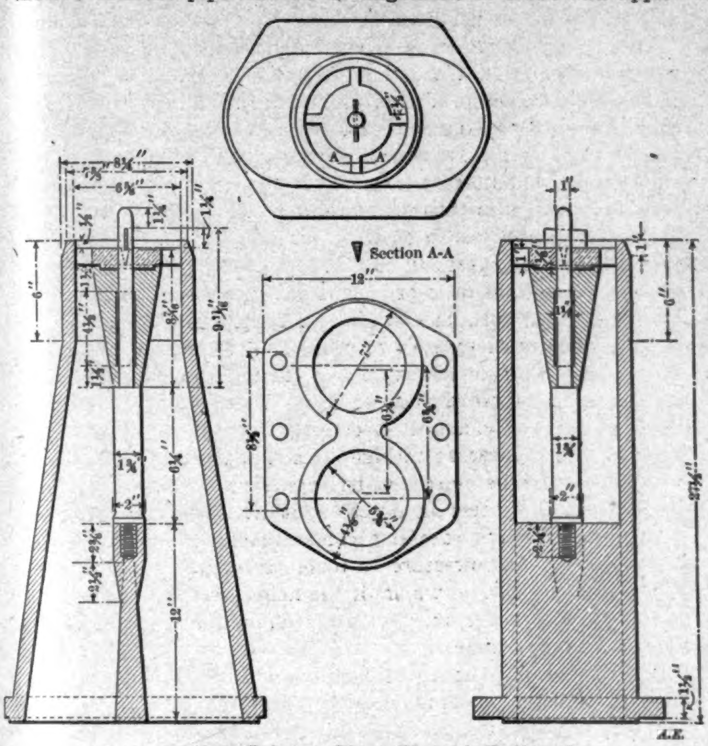
It is not proposed here to discuss the technical side of water analysis, but there are some features of the subject that seem to be little understood by those having to deal practically with the water problem. An inorganic water analysis, as shown by the chemist, is the result of a series of experiments upon the sample to determine what the solid matter contained is, and how in probability it naturally exists. Results would be less confusing if chemists adopted the same scheme of analysis, but they sometimes vary widely, depending on the school or scheme of analysis followed. The proper expression of a water analysis should show what the contents are as bases, acids and elements, as separated by the analyst. Such an expression would, however, be Greek to the layman. He must have a more positive expression in grains per gallon, therefore the chemist gives him one based on a scheme of combination that may or may not show just how the matter exists naturally. The variation in expression by different chemists is not surprising in view of the fact that no method without most careful research can tell just how the combinations do naturally exist, and they may vary in some waters between the time of taking the sample and the opportunity of the analyst. Ordinarily the water analysis for boiler purposes should be considered as an approximation, and the chemist cannot tell exactly now it will act in the steam boiler. The specific action of salts existing is largely influenced by the presence of others. The chemist knows the influence of chlorides, for instance, on deposit, or precipitation of magnesia. As an analyst he must allow for it. The deposit of sulphate of lime or gypsum scale in a steam boiler is undoubtedly diminished if common salt is present in quantity in the water. If largely in excess it is questionable from evidence I have that much scale deposit forms.

The variation in character of water from its source is a point that should be looked into in consideration of water treatment. Generally ground water supplies do not materially vary in character, but certain cases have come under our observation where well supplies have materially changed with the season. It is not practical at the wayside tank to give a water daily analysis to find out exactly what is required, and a commercial result only can be expected. We have found cases where wide variation has existed with the season. A water should have been analyzed several times before considering what average of treatment should be adapted. Surface waters are most liable to be affected, ground less, and artesian water is least likely to vary.

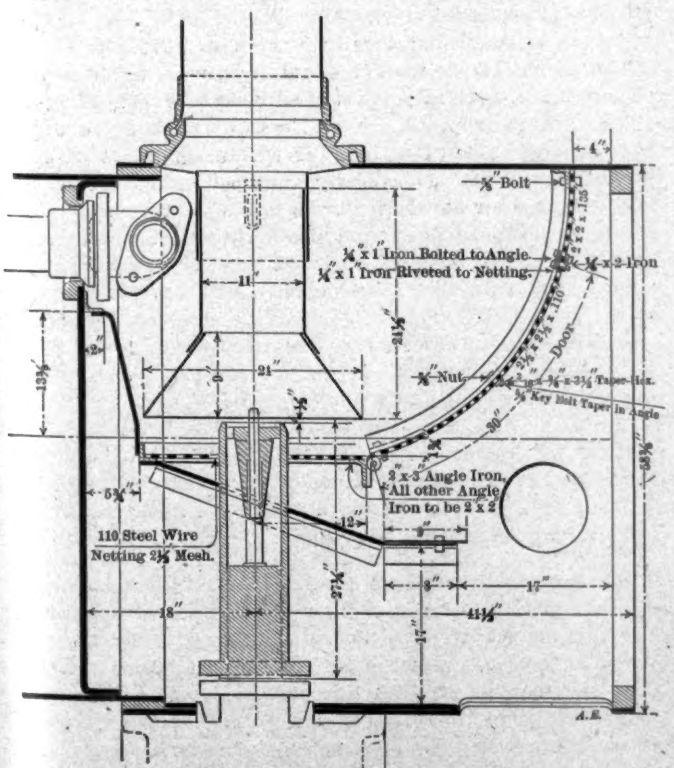
THE BARNES EXHAUST PIPE.

Wabash Railroad.

Mr. J. B. Barnes, Superintendent Motive Power of the Wabash Railroad, has kindly sent us drawings of a new locomotive exhaust pipe and an arrangement of front end appli-



New Exhaust Pipe—Wabash Railroad.
By J. B. Barnes, Superintendent of Motive Power.



Front End Arrangement—Wabash Railroad.
With Barnes' New Exhaust Pipe.

ances, of the performance of which he speaks very highly. His records show a substantial reduction in back pressure, a good effect on the fire and an important saving in coal. He reports a saving of one ton of coal in runs of 100 miles over his former practice, as a rough comparative figure. Twelve of his engines have been fitted with these pipes, including several different types in different classes of service, and they appear to be doing equally well in all.

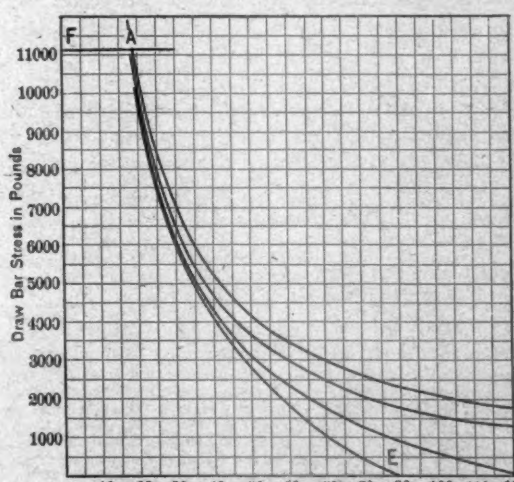
The exhaust pipe has a bridge 12 ins. high, in the center of which a long spindle is screwed. On the top of the spindle an inverted cone is placed. It rests on a shoulder on the spindle and on its top face a spider is placed, with wings, tapered in section, reaching to the sides of the nozzle. The whole is secured by a key driven through a slot in the top of the spindle. To vary the size of the opening different cones and spiders are used, the nozzle diameter remaining unchanged.

The object of this arrangement was to pass the steam out of the nozzle through an annular opening without diminishing the size of the opening. It provides means for issuing the steam in a hollow stream of large diameter, causing less back pressure, and it appears to increase the entraining action of the jet. As shown by indicator cards the back pressure is less than with the ordinary nozzle and the draft effect seems to be very satisfactory, as there is no trouble in keeping fires and front ends free and clean. In the drawing of the front end the relative positions of the nozzle, petticoat pipe diaphragm and nettings are clearly shown. The size of the stack is not indicated in the drawings, but on the blue print it measures 15 ins. This exhaust pipe has been patented by Mr. Barnes.

TRACTIVE POWER AND POWER LOSSES.*

By Prof. W. F. M. Goss.

That which I have to present concerns the effect of changes in speed on the pulling power of the Purdue locomotive, Schenectady No. 2. On this diagram vertical distances represent drawbar stress, while horizontal distances represent speed in miles per hour. Upon this diagram I have first produced the curve A B, representing drawbar stress as calculated from work done in the cylinders. In locating this curve I have not followed the plan which is suggested by Mr. Henderson, but have taken a shorter cut which for the present purpose seems altogether justifiable. That is, I have assumed that under



the conditions to be dealt with, involving a wide range of speed, the maximum power of the engine would be constant, and that it would equal 1 h.p. for every 2.5 sq. ft. of heating surface in the boiler. This curve A B shows, therefore, the work done in the cylinders reduced to pounds pull at the drawbar for all speeds within the capacity of the engine. Below this line A B, I have made another, A C, so placed that the area between the curves A B and A C represents the loss due to the machine friction of the engine. For the locomotive in question this is constant for all speeds and amounts to about 400 lbs. stress at the drawbar. So in effect the second curve subtracts 400 lbs. drawbar stress from the first curve. Its location shows the pulling power of the locomotive at all

*Discussion of Mr. Henderson's paper, "A Practical Tonnage Rating," before the Master Mechanics' Association.

speeds as based on cylinder performance, after machine friction has been deducted. Then there are other losses to be deducted. There is the rolling friction of the truck and tender which when accounted for causes the pull exerted at the drawbar to fall to the line A D. Finally, there is the wind resistance of the head of the train. Subtracting values for this from those shown by the line A D gives results which are represented by the line A E which, according to the best information we have upon the subject, shows the drawbar pull that the particular engine under discussion, which was a small engine, is capable of exerting upon a train at different speeds. It is necessary to cut off the diagram somewhere along the top (A F) because the adhesion is not sufficient to allow the drawbar stress to increase above 12,000 lbs.; and to make this diagram entirely practical, we must end it at a definite point above which, it may be assumed, the engine will not run. Such a speed might be that which is represented by 400 revolutions a minute, but for the present we will consider the diagrams as unlimited as to speed. Reasoning from facts thus presented, it is interesting to note that in the case of this particular engine, the drawbar stress runs out to nothing at a speed of less than 90 miles an hour.

If this engine were at the head of a train running at approximately 90 miles an hour, it would just cease to exert a pull on the drawbar, all its power being absorbed to carry itself along. The diagram shows, also, why it is that the pulling power of a locomotive falls off rapidly as speed is increased. It is not the indicated power that falls off, as many people have supposed, but it is because there are losses between the cylinder and the drawbar power which increase rapidly as the speed is increased. These losses are in all cases represented by the vertical distances between the curves A B and A E. It will be seen that for a speed of 20 miles an hour the vertical distance between A B and A E is small in proportion to the distance from A B to the base line; while at a speed of 60 miles an hour, the losses represented by the distance between A B and A E is about half the total pull as represented by the distance between A B and the base. At 80 miles an hour, the losses amount to practically all the power that is developed. If the facts on this diagram are kept in mind they will serve to explain results which, occurring in practice, often cause comment and surprise. Finally, I should call attention to the fact that the results disclosed by this diagram, applying as they do to a small engine, are in some respects misleading as indicating what may be expected of a modern heavy engine. Some of the losses, more particularly those resulting from atmospheric resistance, are no greater for a large engine than for one that is small, consequently in case of a large engine the reductions to be made from the initial curve are proportionately less than for a small engine. This fact constitutes one of the arguments in favor of the large engine for high-speed work.

SANTA FE ROUTE READING ROOMS.

There are now fourteen railroad reading rooms on the Santa Fe System. Seven of these are located on the A. T. & S. F. and seven on the lines west of Albuquerque. The privileges of these reading rooms consist of the latest books, the leading periodicals of the country, baths, games and lectures on scientific and social subjects by eminent educators, lectures on astronomy, chemistry, geology, physiology, sociology and kindred topics. All these privileges are absolutely free to all employees and their families and the community in the smaller towns has always been invited and welcomed. More than 10,000 books are in circulation on the Santa Fe System. About 40 per cent. of these are fiction, 25 per cent. are historical, 15 per cent. are biographical, 10 per cent. technical and the rest general. The families of the men have free use of the books and periodicals. Any employee has the privilege of ordering any book he may desire to read. On the fairest estimate at the points where these reading rooms are located 90 per cent. of the employees use them.

THE NEW TURBINE STEAMER "KING EDWARD."

Driven by Parsons' Turbines.

The "King Edward," the latest Clyde passenger steamboat, built for the purpose of trying the Parsons' steam turbine machinery for mercantile purposes, has quite justified the courage and enterprise of her owners, says "Engineering" of London.

The "King Edward" is 250 ft. long and 30 ft. wide. Her molded depth is 10 ft. 6 ins. to the main deck and 17 ft. 9 ins. to the promenade deck. The propelling machinery consists of three Parsons' steam turbines working compound. These are placed side by side. In ordinary working, and when going ahead steam is admitted from the boilers to the high-pressure turbine, where it is expanded five-fold. From thence it passes to the two low-pressure or wing turbines placed one on each side, where it is expanded 25-fold and then passes to the condensers. The total ratio of expansion is therefore no less than 125-fold. Each turbine has its own shafting, and on each of the wing shafts there are two propellers, while the center one carries only a single screw. When coming alongside a pier or maneuvering in crowded waters the wing motors alone are used, steam being admitted directly into them by suitable valves. The high-pressure turbine is then shut off, the steam-admission valve being closed, while connection between it and the low-pressure turbines is also shut off by an automatic arrangement. There are special turbines placed inside the exhaust ends of the low-pressure turbines for going astern with the wing screws. The whole of the maneuvering excepting, of course, by the rudder, is effected by the manipulation of valves in a very simple manner.

On June 26, on a mean of runs over the Skelmorlie mile, a speed of 20.48 knots was registered. The mean revolutions were 740 per minute, steam at the boilers was 150 lbs. to the square inch, and the vacuum 26½ ins. The air pressure in the stokehold was equal to 1 in. of water. The indicated horse-power was estimated at 3,500, there being, of course, no means of taking indicator diagrams with this type of motor.

The weight of the motors, condensers, with water in them, steam pipes, auxiliaries connected with the propelling machinery, shafting, propellers, etc., is 66 tons. This, we believe, is considered to be about half the weight per indicated horse-power developed of the average of the propelling machinery of paddle-boats of a similar type. So far as the turbines are concerned, it is not possible to tell whether they are running or not by placing one's hand on them. There is, however, a very slight vibration that can be felt right astern, and this is due to the propellers. Whether this can be eliminated or not remains to be seen, but certainly no vibration is set up by the main engines themselves. At the bow end motion is similar to that of a fast sailing yacht.

In regard to the fine shape of the boat, it may be pointed out that the low center of gravity of the turbine machinery gives good stability without the necessity for a hard bilge or long floor; in fact, this type of machinery lends itself readily to a form of hull conducive to high speed.

The long-distance telephone system has been adopted by the Delaware, Lackawanna and Western Railroad for controlling the movement of their trains instead of by telegraph. The road has a contract with the American Bell Telephone Company to build its own line, and is extending the double copper wire lines which already cover a considerable portion of the main road. The total miles of line now completed are about 250. The wires used are mostly No. 12 copper wire and strung on telegraph poles. The company has private exchanges in New York, Hoboken, Scranton, Binghamton, Elmira, Utica, Syracuse and Buffalo. The main exchange is at Hoboken and has 30 connections, including 13 lines to general and division officers; 7 to piers and yard offices; lines to the ticket office, the baggage room, signal towers, etc. There are also private connections to the homes of several officers of the road.

TABLES OF SPEED OF LOCOMOTIVES.

By R. F. Peters, Houston, Tex.

In taking indicator diagrams from and testing locomotives where each speed has to be taken and figured separately considerable time and work are involved. To avoid this, and also to provide ready means for finding the speeds for different diameters of driver of a locomotive the accompanying tables were prepared.

The divisions of time are ten seconds, one minute and one hour, and are those best adapted to the conditions under which they must be taken and used. Beginning with 5 revolutions for 10 seconds, the number of revolutions increase by 1 to 76. The columns are divided into spaces of five figures each, to facilitate the finding of a number.

Starting at the top right-hand corner, 5 rev. per 10 sec. = 30 rev. per min. = 1,800 rev. per hour: opposite the number of revolutions and in the column of miles per hour, under the diameter of the driver of the locomotive, will be found the exact number of miles per hour to two decimal places. Under each diameter is found the number of revolutions that the driver makes in one mile.

Example: A locomotive having 66-in. drivers makes 23 revolutions in 10 seconds (or 138 in 1 minute) under a certain load. Find the speed. Follow the first column down until 23 is found, then look to the left, opposite 23 and under 66 ins. we find 27.08, which is the speed in miles per hour.

Dia of Driver — Number of Revolutions Per Mile — Number of Miles Per Hour

55"	56"	57"	58"	59"	60"	61"	62"	63	64"	65"	66"	67	68"	69"	70"	71"	72"	73"	74"	75"	76"	77"	78"	79"	80"	81"	82"	83"	84"	85"	Rev. Per		
366.7	360.1	353.6	347.7	341.8	336.1	330.6	325.3	320.1	315.1	310.2	305.6	301.0	296.6	292.3	288.1	284.0	280.1	276.2	272.5	268.9	265.3	261.9	258.6	255.3	252.1	249.0	245.9	243.0	240.1	237.3	1 Hour	1 Min	10 Sec
4.90	4.99	5.06	5.10	5.26	5.35	5.44	5.53	5.62	5.71	5.80	5.89	5.98	6.06	6.16	6.24	6.33	6.42	6.51	6.60	6.69	6.78	6.87	6.96	7.05	7.14	7.22	7.32	7.40	7.49	7.58	1800	30	5
5.89	5.99	6.15	6.21	6.31	6.42	6.53	6.64	6.74	6.85	6.96	7.07	7.17	7.28	7.39	7.49	7.59	7.71	7.81	7.92	8.03	8.14	8.24	8.36	8.46	8.56	8.67	8.78	8.88	8.99	9.09	2160	36	6
6.87	6.99	7.12	7.24	7.37	7.49	7.62	7.74	7.87	7.99	8.12	8.24	8.37	8.49	8.62	8.73	8.86	8.99	9.12	9.24	9.36	9.49	9.62	9.75	9.87	9.99	10.11	10.24	10.36	10.49	10.61	2520	42	7
7.85	7.99	8.14	8.27	8.42	8.56	8.71	8.85	8.98	9.01	9.28	9.42	9.56	9.70	9.85	9.98	10.13	10.27	10.42	10.56	10.70	10.85	10.99	11.14	11.28	11.41	11.56	11.71	11.85	11.98	12.13	2880	48	8
8.83	8.99	9.15	9.31	9.48	9.64	9.80	9.96	10.12	10.28	10.44	10.60	10.76	10.92	11.08	11.23	11.39	11.56	11.72	11.89	12.04	12.20	12.36	12.54	12.69	12.85	13.00	13.17	13.33	13.47	13.64	3240	54	9
9.81	9.99	10.17	10.35	10.53	10.71	10.89	11.05	11.24	11.43	11.60	11.78	11.96	12.13	12.32	12.49	12.66	12.84	13.03	13.21	13.38	13.56	13.74	13.93	14.10	14.28	14.45	14.64	14.81	14.97	15.16	3600	60	10
10.79	10.99	11.19	11.38	11.58	11.78	11.97	12.18	12.36	12.56	12.76	12.96	13.15	13.34	13.55	13.73	13.93	14.13	14.33	14.53	14.72	14.91	15.11	15.32	15.51	15.70	15.89	16.10	16.29	16.46	16.68	3960	66	11
11.78	11.98	12.21	12.42	12.62	12.85	13.06	13.28	13.49	13.71	13.92	14.14	14.35	14.55	14.78	14.98	15.19	15.41	15.63	15.85	16.06	16.27	16.49	16.71	16.92	17.13	17.34	17.56	17.77	17.96	18.20	4320	72	12
12.76	12.99	13.22	13.45	13.69	13.92	14.15	14.07	14.62	14.85	15.08	15.30	15.54	15.77	16.00	16.23	16.46	16.70	16.94	17.17	17.39	17.63	17.86	18.11	18.33	18.56	18.78	19.03	19.25	19.45	19.71	4680	78	13
13.74	13.99	14.24	14.49	14.74	14.99	15.24	15.49	15.74	15.99	16.24	16.46	16.74	16.99	17.24	17.49	17.74	17.98	18.24	18.49	18.74	18.99	19.24	19.51	19.74	19.99	20.24	20.49	20.74	20.99	21.23	5040	84	14
14.72	14.99	15.26	15.52	15.78	16.06	16.33	16.60	16.86	17.13	17.40	17.65	17.94	18.20	18.48	18.74	19.00	19.17	19.54	19.81	20.08	20.35	20.61	20.90	21.15	21.42	21.68	21.96	22.22	22.48	22.76	5400	90	15
15.70	15.99	16.27	16.56	16.82	17.13	17.42	17.70	17.98	18.27	18.56	18.83	19.13	19.41	19.71	19.99	20.27	20.55	20.85	21.13	21.41	21.71	21.98	22.29	22.56	22.84	23.13	23.42	23.70	23.98	24.26	5760	96	16
16.68	16.99	17.29	17.60	17.90	18.20	18.51	18.81	19.11	19.41	19.72	20.01	20.33	20.62	20.91	21.24	21.54	21.74	22.15	22.45	22.71	23.06	23.36	23.69	23.97	24.27	24.57	24.88	25.18	25.47	25.78	6120	102	17
17.67	17.99	18.31	18.63	18.95	19.28	19.60	19.92	20.24	20.56	20.88	21.19	21.53	21.84	22.13	22.48	22.80	23.02	23.45	23.77	24.09	24.42	24.73	25.08	25.38	25.70	26.02	26.35	26.66	26.97	27.30	6480	108	18
18.65	18.99	19.33	19.66	19.99	20.35	20.67	21.02	21.35	21.70	22.04	22.37	22.72	23.05	23.40	23.73	24.07	24.31	24.75	25.09	25.43	25.77	26.10	26.47	26.79	27.13	27.46	27.81	28.14	28.46	28.81	6840	114	19
19.63	19.99	20.35	20.70	21.06	21.42	21.74	22.13	22.49	22.84	23.20	23.55	23.92	24.26	24.64	24.98	25.34	25.59	26.06	26.42	26.77	27.13	27.48	27.87	28.20	28.56	28.91	29.28	29.62	29.96	30.33	7200	120	20
20.61	20.99	21.37	21.74	22.11	22.47	22.87	23.24	23.50	23.98	24.36	24.72	25.11	25.45	25.86	26.23	26.60	26.88	27.36	27.74	28.11	28.49	28.85	29.26	29.61	29.98	30.35	30.74	31.10	31.45	31.85	7560	126	21
21.59	21.99	22.39	22.77	23.16	23.56	23.95	24.34	24.74	25.13	25.53	25.90	26.31	26.69	27.10	27.40	27.87	28.17	28.65	29.06	29.45	29.84	30.23	30.65	31.02	31.41	31.80	32.20	32.58	32.95	33.37	7920	132	22
22.57	22.99	23.41	23.80	24.22	24.63	25.04	25.45	25.85	26.27	26.69	27.08	27.51	27.90	28.33	28.73	29.14	29.46	29.97	30.38	30.79	31.20	31.60	32.04	32.43	32.84	33.24	33.67	34.06	34.44	34.88	8280	138	23
23.56	23.99	24.42	24.84	25.26	25.70	26.13	26.56	26.99	27.41	27.85	28.25	28.70	29.13	29.56	29.98	30.41	30.74	31.28	31.70	32.13	32.56	32.98	33.44	33.84	34.27	34.69	35.13	35.55	35.98	36.40	8640	144	24
24.54	24.99	25.43	25.88	26.30	26.77	27.22	27.66	28.11	28.55	29.01	29.45	29.90	30.34	30.80	31.23	31.67	32.03	32.58	33.02	33.47	33.92	34.36	34.84	35.25	35.70	36.14	36.60	37.03	37.48	37.92	9000	150	25
25.52	25.99	26.45	26.91	27.38	27.81	28.31	28.76	29.24	29.70	30.17	30.63	31.09	31.56	32.03	32.48	32.94	33.31	33.89	34.34	34.84	35.27	35.73	36.23	36.66	37.12	37.60	38.06	38.52	38.97	39.43	9360	156	26
26.50	26.99	27.47	27.95	28.43	28.90	29.40	29.88	30.36	30.84	31.33	31.81	32.29	32.76	33.26	33.73	34.22	34.60	35.19	35.66	36.14	36.63	37.11	37.62	38.07	38.55	39.03	39.52	40.00	40.47	40.95	9720	162	27
27.48	27.99	28.49	28.90	29.14	29.99	30.48	30.98	31.49	31.98	32.47	32.99	33.50	33.97	34.63	34.97	35.38	35.88	36.49	36.98	37.49	37.99	38.48	39.02	39.48	39.98	40.47	40.99	41.48	41.96	42.46	10080	168	28
28.47	28.99	29.50	30.02	30.53	31.06	31.57	32.09	32.61	33.12	33.65	34.17	34.78	35.19	35.72	36.22	36.65	37.19	37.79	38.31	38.82	39.34	39.85	40.41	40.89	41.41	41.92	42.45	42.96	43.46	43.99	10440	174	29
29.46	29.99	30.52	31.06	31.59	32.13	32.66	33.20	33.73	34.27	34.81	35.35	35.90	36.46	36.92	37.47	37.92	38.45	39.10	39.63	40.16	40.70	41.23	41.80	42.30	42.84	43.38	43.92	44.44	44.95	45.50	10800	180	30
30.42	30.99	31.04	32.09	32.65	33.20	33.75	34.30	34.86	35.41	35.97	36.52	37.07	37.61	38.19	38.72	39.18	39.85	40.40	40.95	41.50	42.05	42.60	43.20	43.71	44.26	44.81	45.38	45.92	46.45	47.01	11160	186	31
31.41	31.99	32.56	33.12	33.70	34.27	34.84	35.42	35.98	36.56	37.13	37.70	38.37	38.83	39.42	39.97	40.45	41.11	41.70	42.27	42.84	43.41	43.98	44.57	45.12	45.69	46.25	46.85	47.40	47.94	48.53	11520	192	32
32.39	32.99	33.50	34.16	34.75	35.34	35.93	36.51	37.11	37.69	38.29	38.88	39.56	40.04	40.65	41.22	41.72	42.40	43.01	43.59	44.17	44.78	45.35	45.98	46.53	47.12	47.70	48.31	48.88	49.44	50.05	11880	198	33
33.37	33.99	34.59	35.20	35.81	36.41	37.02	37.62	38.23	38.84	39.45	40.06	40.66	41.26	41.88	42.48	43.09	43.68	44.31	44.91	45.51	46.13	46.73	47.38	47.94	48.55	49.14	49.77	50.37	50.90	51.58	12240	204	34
34.36	34.99	35.61	36.28	36.86	37.46	38.11	38.78	39.36	39.98	40.61	41.24	41.86	42.47	43.11	43.72	44.35	44.97	45.61	46.23	46.85	47.47	48.10	48.77	49.35	49.98	50.59	51.23	51.85	52.48	53.10	12600	210	35
35.34	35.99	36.63	37.26	37.91	38.55	39.20	39.84	40.48	41.12	41.77	42.42	43.05	43.68	44.35	44.97	45.62	46.25	46.92	47.55	48.95	48.86	49.48	50.17	50.76	51.40	52.14	52.70	53.33	53.97	54.61	12960	216	36
36.32	36.99	37.65	38.28	38.95	39.62	40.29	40.94	41.61	42.26	42.98	43.60	44.25	44.89	45.58	46.22	46.89	47.54	48.22	48.87	49.53	50.28	50.85	51.56	52.17	52.83	53.48	54.16	54.81	55.47	56.13	13320	222	37
37.30	37.99	38.67	38.31	39.99	40.70	41.35	42.05	42.73	43.41	44.10	44.77	45.44	46.11	46.81	47.47	48.15	48.82	49.52	50.19	50.78	51.56	52.23	52.95	53.58	54.26	54.98	55.62	56.29	56.96	57.65	13680	228	38
38.28	38.99	39.69	40.32	41.03	41.77	42.46	43.16	43.86	44.55	45.26	45.95	46.96	47.32	47.04	48.72	49.52	50.11	50.82	51.52	52.21	52.91	53.60	54.35	54.99	55.69	56.37	57.09	57.77	58.46	59.16	14040	234	39
39.26	39.99	40.70	41.35	42.13	42.84	43.55	44.26	44.98	45.64	46.42	47.13	47.84	48.59	49.28	49.97	50.69	51.39	52.13	52.84	53.55	54.27	54.97	55.74	56.41	57.12	57.82	58.55	59.25	59.95	60.60	14400	240	40

R. F. Peters.

Dia of Driver — Number of Revolutions Per Mile — Number of Miles Per Hour

55"	56"	57"	58"	59"	60"	61"	62"	63"	64"	65"	66"	67"	68"	69"	70"	71"	72"	73"	74"	75"	76"	77"	78"	79"	80"	81"	82"	83"	84"	85"	Rev. Per		
366.7	360.1	353.6	347.7	341.8	336.1	330.6	325.3	320.1	315.1	310.2	305.5	301.0	296.6	292.3	288.1	284.0	280.1	276.2	272.5	268.9	266.3	261.9	258.6	255.3	252.1	249.0	245.9	243.0	240.1	237.3	1 Hour	1 Min	10 Sec
40.25	40.99	41.71	42.29	43.18	43.91	44.64	45.37	46.11	46.84	47.58	48.31	49.05	49.80	50.51	51.32	51.95	52.68	53.40	54.16	54.88	55.62	56.35	57.13	57.81	58.54	59.26	60.02	60.73	61.45	62.28	14760	246	41
41.23	41.99	42.73	43.42	44.23	44.98	45.73	46.44	47.23	47.96	48.74	49.49	50.23	51.02	51.74	52.47	53.21	52.96	54.73	55.48	56.22	56.98	57.72	58.53	59.22	59.97	60.71	61.48	62.21	62.94	63.72	15120	252	42
42.21	42.99	43.75	44.45	45.28	45.98	46.82	47.56	48.32	49.12	49.90	50.67	51.42	52.23	52.97	53.72	54.49	55.25	56.04	56.80	57.56	58.34	59.10	59.92	60.63	61.40	62.15	62.94	63.69	64.44	65.72	15480	258	43
43.19	43.99	44.77	45.49	46.34	47.13	47.92	48.69	49.48	50.28	51.06	51.84	52.62	53.44	54.20	54.98	55.77	56.55	57.35	58.12	58.90	59.69	60.48	61.32	62.04	62.83	63.61	64.41	65.18	65.97	66.75	15840	264	44
44.17	44.99	45.79	46.53	47.39	48.19	49.00	49.78	50.60	51.41	52.22	53.02	53.81	54.65	55.44	56.22	57.03	57.83	58.65	59.44	60.24	61.06	61.85	62.71	63.45	64.26	65.05	65.87	66.66	67.46	68.27	16200	270	45
45.15	45.99	46.80	47.56	48.44	49.21	50.09	50.90	51.70	52.58	53.38	54.20	55.01	55.86	56.67	57.47	58.30	59.12	59.95	60.76	61.58	62.41	63.22	64.11	64.86	65.68	66.50	67.34	68.14	68.96	69.78	16560	276	46
46.14	46.99	47.82	48.59	49.44	50.34	51.17	52.01	52.85	53.69	54.54	55.38	56.21	57.07	57.90	58.72	59.57	60.40	61.26	62.08	62.92	63.77	64.60	65.50	66.27	67.11	67.94	68.80	69.62	70.45	71.30	16920	282	47
47.12	47.99	48.84	49.64	50.55	51.41	52.26	53.12	53.98	54.85	55.70	56.56	57.40	58.29	59.13	59.97	60.83	61.69	62.56	63.40	64.26	65.12	65.97	66.89	67.68	68.54	69.39	70.26	71.10	71.95	72.82	17280	288	48
48.10	48.99	49.86	50.73	51.60	52.48	53.35	54.22	55.10	55.98	56.86	57.74	58.60	59.50	60.37	61.22	62.10	62.97	63.86	64.73	65.60	66.48	67.35	68.28	69.09	69.97	70.83	71.73	72.59	73.44	74.33	17640	294	49
49.08	49.99	50.87	51.76	52.68	53.55	54.44	55.33	56.23	57.12	58.02	58.91	59.79	60.71	61.60	62.47	63.37	64.26	65.17	66.05	66.93	67.84	68.72	69.68	70.50	71.40	72.28	73.19	74.07	74.94	75.85	18000	300	50
50.06	50.99	51.89	52.80	53.71	54.62	55.53	56.44	57.39	58.26	59.18	60.09	60.99	61.93	62.83	63.72	64.64	65.54	66.47	67.37	68.27	69.19	70.09	71.07	71.91	72.82	73.72	74.76	75.56	76.43	77.37	18360	306	51
51.04	51.99	52.91	53.83	54.76	55.69	56.62	57.54	58.48	59.40	60.34	61.27	62.19	63.14	64.06	64.97	65.90	66.83	67.77	68.69	69.61	70.55	71.47	72.46	73.32	74.25	75.17	76.22	77.04	77.93	78.89	18720	312	52
52.03	52.99	53.92	54.86	55.84	56.76	57.70	58.65	59.55	60.55	61.50	62.45	63.38	64.35	65.29	66.22	67.17	68.11	69.08	70.01	70.95	71.90	72.84	73.86	74.73	75.68	76.61	77.68	78.52	79.42	80.40	19080	318	53
53.01	53.99	54.94	55.91	56.96	57.83	58.80	59.76	60.73	61.69	62.66	63.63	64.58	65.55	66.52	67.47	68.45	69.49	70.38	71.33	72.29	73.27	74.22	75.26	76.14	77.11	78.07	79.01	80.00	80.96	81.92	19440	324	54
53.99	54.99	55.96	56.94	57.95	58.90	59.89	60.86	61.86	62.83	63.82	64.81	65.78	66.76	67.76	68.71	69.71	70.77	71.68	72.65	73.63	74.61	75.59	76.65	77.55	78.54	79.51	80.47	81.48	82.46	83.44	19800	330	55
54.97	55.99	56.98	57.97	59.00	59.97	60.98	61.97	62.97	63.97	64.89	65.98	66.97	67.97	68.99	69.96	70.98	72.06	72.98	73.97	74.97	75.98	76.97	78.04	78.96	79.96	80.96	81.94	82.96	83.95	84.95	20160	336	56
55.95	56.99	58.00	59.00	60.05	61.04	62.06	63.07	64.09	65.12	66.15	67.16	68.17	69.18	70.22	71.21	72.25	73.34	74.29	75.29	76.31	77.34	78.34	79.44	80.37	81.39	82.40	83.40	84.44	85.45	86.46	20520	342	57
56.93	57.99	59.02	60.03	61.10	62.11	63.12	64.18	65.21	66.26	67.31	68.34	69.36	70.39	71.45	72.46	73.51	74.63	75.59	76.62	77.64	78.69	79.72	80.83	81.78	82.82	83.85	84.97	85.92	86.94	87.98	20880	348	58
57.91	58.99	60.04	61.06	62.15	63.18	64.20	65.29	66.33	67.40	68.47	69.52	70.56	71.60	72.68	73.71	74.78	75.91	76.89	77.94	78.98	80.05	81.09	82.22	83.19	84.25	85.29	86.43	87.40	88.44	89.50	21240	354	59
58.89	59.99	61.06	62.09	63.20	64.25	65.28	66.39	67.45	68.54	69.63	70.70	71.76	72.82	73.92	74.96	76.05	77.10	78.20	79.26	80.32	81.41	82.46	83.62	84.60	85.68	86.74	87.90	88.88	89.93	91.02	21600	360	60
59.87	61.00	62.08	63.12	64.25	65.32	66.36	67.57	68.57	69.69	70.79	71.88	72.95	74.04	75.15	76.21	77.31	78.38	79.50	80.58	81.66	82.76	83.84	85.01	86.01	87.10	88.18	89.36	90.36	91.44	92.54	21960	366	61
60.85	62.00	63.10	64.15	65.30	66.39	67.44	68.61	69.69	70.83	71.95	73.06	74.15	75.25	76.38	77.46	78.58	79.67	80.80	81.90	82.00	84.12	85.21	86.40	87.42	88.53	89.63	90.82	91.84	92.95	94.05	22320	372	62
61.83	63.00	64.12	65.18	66.35	67.46	68.52	69.71	70.81	71.97	73.11	74.23	75.34	76.47	77.61	78.71	79.85	80.95	82.11	83.22	84.34	85.47	86.59	87.80	88.83	89.96	91.07	92.29	93.32	94.44	95.57	22680	378	63
62.81	64.00	65.14	66.21	67.40	68.53	69.60	70.83	71.97	73.11	74.27	75.41	76.52	77.68	78.85	79.97	81.12	82.24	83.41	84.56	85.68	86.83	87.97	89.19	90.24	91.39	92.53	93.69	94.81	95.95	97.09	23040	384	64
63.79	65.00	66.16	67.24	68.45	69.62	70.78	71.93	73.09	74.26	75.43	76.59	77.71	78.89	80.08	81.21	82.38	83.52	84.71	85.87	87.02	88.20	89.34	90.58	91.65	92.82	93.97	96.16	96.29	97.45	98.60	23400	390	65
64.77	66.00	67.18	68.27	69.50	70.69	71.87	73.04	74.21	75.40	76.59	77.77	78.91	80.10	81.31	82.46	84.65	84.81	86.01	87.19	88.35	89.55	90.72	91.98	93.06	94.24	95.42	97.62	97.77	98.94	100.12	23760	396	66
65.75	67.00	68.20	69.30	70.55	71.76	72.96	74.14	75.33	76.54	77.75	78.95	80.01	81.32	82.54	83.71	85.92	86.09	87.32	88.51	89.69	90.91	92.09	93.37	94.47	95.67	96.86	99.08	99.25	100.44	101.62	24120	402	67
66.73	68.00	69.23	70.33	71.60	72.83	74.05	75.25	76.45	77.68	78.91	80.13	81.30	82.53	83.77	84.96	87.18	87.38	88.62	89.83	91.03	92.26	93.46	94.76	95.88	97.10	98.31	100.55	100.73	101.93	103.13	24480	408	68
67.71	69.00	70.25	71.36	72.65	73.90	75.13	76.32	77.57	78.83	80.07	81.30	82.50	83.74	85.01	86.21	88.45	88.60	89.92	91.15	92.37	93.62	94.84	96.16	97.29	98.53	99.75	102.01	102.21	103.43	104.65	24840	414	69
68.69	70.00	71.27	72.39	73.71	74.97	76.22	77.46	78.69	79.97	81.23	82.48	83.69	84.95	86.24	87.46	89.72	89.89	91.23	92.47	93.71	94.97	96.21	97.55	98.70	99.96	101.20	103.48	103.69	104.93	106.17	25200	420	70
69.67	71.00	72.30	75.42	74.76	76.04	77.31	78.58	79.81	81.11	82.39	83.66	84.89	86.17	87.47	88.71	90.98	91.17	92.53	93.79	95.05	96.33	97.60	98.94	100.11	101.38	102.64	104.94	105.17	106.42	107.69	25560	426	71
70.65	72.00	73.32	76.45	75.82	77.11	78.40	79.68	80.95	82.25	83.55	84.84	86.08	87.38	88.70	89.96	92.35	92.46	93.83	95.11	96.39	97.69	98.97	100.33	101.52	102.81	103.99	106.40	106.65	107.92	110.20	25920	432	72
71.63	73.00	74.34	77.48	76.87	78.18	79.49	80.78	82.05	83.39	84.71	86.02	87.28	88.59	89.93	91.21	93.79	93.47	95.14	96.43	97.73	99.05	100.34	101.73	102.93	104.24	104.93	107.86	108.13	109.41	111.72	26280	438	73
72.61	74.00	75.36	78.51	77.92	79.26	80.58	81.89	83.19	84.54	85.88	87.20	88.60	89.81	91.17	92.46	95.05	95.10	96.44	97.76	100.08	100.40	101.72	103.12	104.34	105.67	106.38	109.33	109.63	110.91	113.24	26640	444	74
73.59	75.00	76.40	79.54	78.97	80.31	81.66	83.00	84.31	85.68	87.05	88.37	89.70	91.02	92.40	93.70	96.32	96.38	97.74	99.08	101.40	101.75	103.09	104.51	105.75	107.10	107.82	110.79	111.11	112.40	114.75	27000	450	75
74.57	76.00	77.42	80.57	81.00	81.40	82.75	84.15	85.43	86.82	88.21	89.55	90.99	92.23	93.63	94.95	97.59	97.66	99.04	100.40	102.54	103.11	104.47	105.51	107.16	108.52	109.27	102.26	112.59	113.90	116.27	27360	456	76

R. F. Peters.

(Established 1832.)

AMERICAN ENGINEER AND RAILROAD JOURNAL.

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SEPTEMBER, 1901.

A correspondent in another column of this issue states the cost of installing track scales for weighing locomotive coal for a road having 1,300 locomotives to be approximately $23,000 and the cost of operation per year to be about $41,472, which, in order to secure an advantage on the investment would call for the saving of $42,852 per year in fuel. It is reasonable to suppose that such an installation would pay, but is it not better to construct chutes in which the coal can be handled cheaply and at the same time be weighed by the attendants as it is delivered? Such apparatus can be used in places where it is impossible to find room for track scales, and considerable attention has been concentrated upon the development of coal-weighing apparatus of this kind, which will permit of weighing the coal in the chutes themselves. Undoubtedly the traveling expert fireman is the most fruitful agent in coal saving, but he must be fortified by a system whereby the records of the enginemen can be accurate and fair, and one which will impress its fairness upon the men. Nothing can be accomplished without the hearty interest and co-operation of the men and a proper method of weighing coal is the real starting point with them. After correctly weighing the coal it must be correctly charged and the record must be understood by the men to be on this basis. What seems to be most needed is a weighing device or method of suspending large chutes whereby the coal may be weighed conveniently as it is delivered and by the coal chute attendants without additional labor costs. There is a demand for such a device now and the chutes should be built to take coal from hopper cars without shoveling.

THE TANDEM COMPOUND.

Compound locomotives with tandem cylinders are not new. They have been used experimentally on the Boston & Albany in 1883, on the North British Railway in 1885 (the locomotive taken from the wreck of the Tay Bridge was converted into this type in that year), on other foreign roads and on the Great Northern and the Atchison in this country. Until now, however, designers have not turned to this type as a solution of difficulties or as a direction in which to pursue further development. There seems to be good reason to believe the tandem to be an important step in the progress of the compound, although it is not free from objections, for example, the reciprocating parts must be heavy. Judging from opinions which have been expressed to us it seems to appeal to some who heretofore have been skeptical as to all types of compounds. There is a limit to the size of the low-pressure cylinders of the two-cylinder type and this has undoubtedly already been reached. For compounds of large capacity four cylinders therefore seem to be absolutely necessary, and it becomes merely a question as to how they shall be arranged. In this issue will be found a description of the new Schenectady Locomotive design which is interesting in itself and is a distinct mark in favor of four cylinders.

This step by the Schenectady Works does not indicate that the two-cylinder type of which so many successful examples are in service is to be abandoned. Probably many more will be built. The tandem meets some important objections and it may perhaps open the way for another step which has already been taken abroad and which several conservative American locomotive authorities now admit to be a probability in their own practice, viz., the four-cylinder arrangement of De Glehn or Webb adapted to American ideas of simplicity. These will not come into favor until found to be necessary, but there can be no doubt that they are looked upon with increasing interest in this country.

THE NEW YORK CENTRAL TUNNEL.

A grand jury investigation of the Park Avenue tunnel of the New York Central, whereby its passenger trains reach the Grand Central station, has been made on behalf of a number of residents who made a concerted complaint. After giving due regard to the expert opinions usually brought out in such cases the matter rests where it was before, the only accomplishment of the investigation being a vigorous public protest against the present situation with respect to ventilation and a renewed activity on the part of the railroad to remedy it. This is not really a tunnel, but a subway under a fashionable avenue. It has four tracks, two of them in a channel open above as much as could be done without inconveniencing the residents and at each side of this is a separate tunnel with arches opening into the central channel. This gave no great trouble when there were few trains, but now with 500 or 600 every day and many switching movements the ventilation is troublesome to passengers and the gases from the locomotives are complained of by the residents. These objections are, of course, aggravated by the extremely warm weather of this summer.

Innumerable impracticable schemes are suggested, but a careful consideration of the situation reveals a most difficult problem, for the solution of which there is no precedent. This agitation will undoubtedly hasten matters, but we state with authority that the railroad officers are not and have not been indifferent, and that they are making a thorough study of the situation, in order to reach the fundamentals and provide permanent relief. This is not a ventilation question alone. The whole problem of a busy terminal in the contracted space of a thickly settled city is involved. Suburban and through trains must be provided for. It is easy to furnish facilities for either alone, but to take care of both in such a contracted space as this terminal is a problem which at present no one knows how to solve. Something must be done soon, because of the rapid increase of traffic. Furthermore, suburban service at this station under present conditions requires locomotives heavier than were necessary for through trains a few years ago, and these schedules are among the most difficult of all to maintain.

Something radical is needed, and the conditions are such as to point toward electric traction for all but the long distance trains as the most promising suggestion. But electrical engineers have not yet shown the way to handle such traffic. Electric locomotives cannot be exchanged for the steam locomotives outside of the city, because the delay of changing would tie up the terminal. A busy yard full of switches and slips and movable point frogs is no place for electric and steam traffic to mix, therefore a separation of tracks is necessary. We are able to state positively that the officers of the New York Central are busy on this problem and are gathering information at home and abroad. Nothing has been decided upon and no one can say what will be done, but it is probable that the entire suburban districts of the three roads running into this station will be equipped for electric traction for a distance of about 50 miles from the city. These trains may be run through the outside galleries of the "tunnel" and the through trains, hauled by steam locomotives, in the central channel. In order to separate the steam and electric lines the

latter may be run into the station on a sub-level below the present train shed.

This is the problem, and it involves the expenditure of millions. The railroads are fully justified in their present careful course and our investigation leads us to believe that one of the most important, most thorough and most interesting problems in transportation is to be worked out here. The men intrusted with the management of these properties are not given to slighting difficulties. They have enlisted the assistance of the best engineers in the world. The result is worth waiting for patiently.

CORRESPONDENCE.

CAST STEEL LOCOMOTIVE FRAMES.

To the Editor:

The diversity of problems and conditions which confront the engineer in locomotive frame construction renders a proper criticism of a special design, in the abstract, a difficult task. For example, adequate lateral bracing may make preferable a section, the use of which, with circumstances existing in another case, would be most undesirable. For this reason a discussion of the carefully prepared design of Mr. De Lamater, illustrated on page 149 in your May issue, can be made in but a very general way.

The nature of the casting necessarily eliminates the use of coring, which reduces the number of practical sections available to three, viz., rectangular, I section and channel section, each having its merits and demerits. Past practice has favored almost without exception the use of rectangular sections, a number of reasons for this suggest themselves, four being here given.

(1) A selection of any form of web section makes necessary a careful and complete design of the engine before constructing a pattern, as proper provision for all bolts and braces is absolutely essential. With the present demand for steel castings and consequent rush in placing orders, "Delivery" being the watchword, to this cause may in part be traced the adherence to this section.

(2) Maintenance and first cost going hand in hand with the motive power official, the apparent advantages of this section for repairs in some cases accounts for its adoption.

(3) Structural conditions being such as to limit cross-bracing, making considerations of side stiffness of the frame important, have doubtless entered as a factor in other instances.

(4) Uncertainty of the product—due to blow holes, etc.—has with others given favor to this section, which by its larger sectional area from this standpoint ensures a higher factor of safety.

With the demand for greater power in proportion to weight—the doing away with the dead load and transferring its equivalent to parts where it may be of value, viz., boiler and cylinders, etc.—considerable attention has been paid to the lightening of detail parts, but the frame, a most important factor from this standpoint, has as yet received but little attention. This being the basis of Mr. De Lamater's design as submitted, its presentation seems opportune and a careful study important in the making of which we may consider four questions:

(1) First cost—dependent on market conditions—needs specific consideration, as this varies with the casting. In a general way, however, either of the web sections, from the greater care required in moulding, will cost more per unit weight. This apparent disadvantage, however, in the writer's opinion, is more than counteracted by a decrease in the amount of stock necessary for machining, occasioned by improved workmanship which it demands in the foundry. Inasmuch as it will be necessary to nail up the cope with the I section, the channel section as used in the main part has an advantage for the moulder—with a possible slight decrease in cost. In pouring, inasmuch as with the I section the portion above the web must be made to flow up into the cope, to ensure an equal percentage of sound castings greater attention is required, with consequent increased cost to the manufacturer. As taken from the sand, warpage will exist with present facilities. To straighten the submitted design—more especially about the pedestal jaws with the corner ribs—is a somewhat difficult, hence expensive job, much more so than with either of the other sections. With the regular rectangular section and design it seems necessary to finish the frames all over. This item by use of risers and a careful consideration of the plan, can be materially reduced. For example, let the pedestal jaws be arranged as shown in Fig. 1. The planer travel can be reduced to say 36 ins.; then shifted to the second, and so on, the engine being set up from these.

(2) Except for the differences in material, rectangular sections of steel and iron present similar difficulties in repair work. Let it be supposed that Mr. De Lamater's design develops a crack as indicated in Fig. 2. The problem confronting the smith is left for analysis. Were the section rectangular a "dutchman," if need be, is inserted and a weld made. A revision of this portion of the design is suggested similar to the

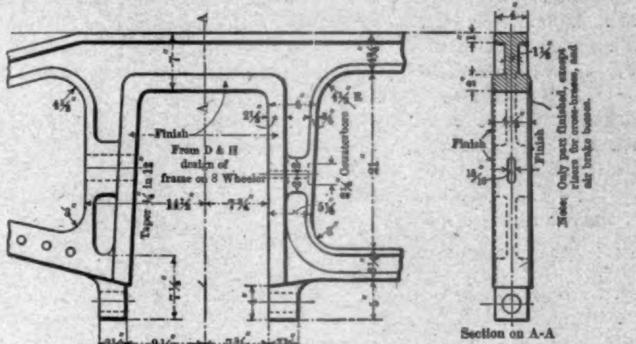


Fig. 1

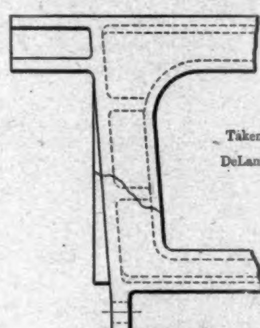


Fig. 2

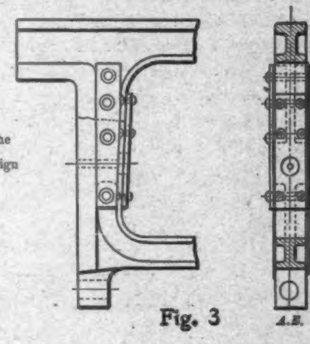


Fig. 3

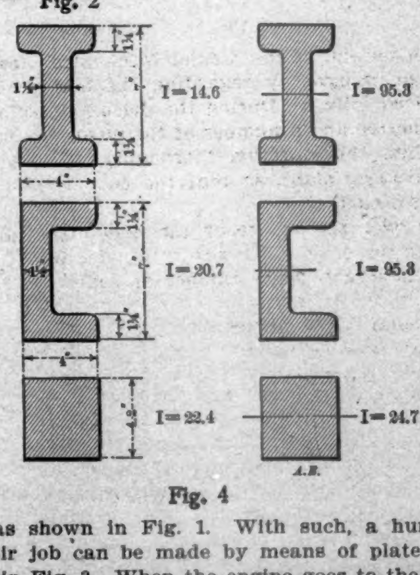


Fig. 4

I section as shown in Fig. 1. With such, a hurried roundhouse repair job can be made by means of plates riveted as illustrated in Fig. 3. When the engine goes to the shop, filling blocks can be secured at either side and if it is deemed desirable the frame may be milled to section as before. Under this heading a division of the casting in two parts is advised and a substitution of hammered iron of rectangular section suggested for the front rails. The work is straight and the engine attachments are numerous.

(3) The complex nature of the forces acting on engine frames make an analysis with determination of the stresses a difficult problem. In preference, we must avail ourselves of the teachings of experience, and an equivalent section in strength must be designed. The formulæ being the same in a comparative

calculation, except for moment of inertia of section, the accompanying data of sections equal in weight are arranged as in Fig. 4. From these the absolute need of additional cross-bracing with web sections, more especially the I section, is seen, the arrangement and possible provisions for which is governed by the specific design under consideration. Frames of to-day have an average ultimate strength per square inch of original section of 60,000 to 67,000 lbs., with an elongation of 23 to 30 per cent.

(4) Under the heading of durability may be properly discussed shrinkage effects, inasmuch as upon the elimination of such depends materially the life of the frame. By nearly uniform and comparatively small thickness of metal these exist in much less intensity than with the rectangular section. Experience, however, gives rise to the suggestion of increased radii with a considerable number of the fillets. Here, almost without exception, first failures are discovered. Provision for irregularities in shrinkage, which invariably exist in the casting, would give rise to an increase in several instances of the thicknesses of the finished parts. Noting, for example, the pedestal sketch, Fig. 2, the inner web should not on this account, together with proper provision for shoe and wedge bearing surface, be made less than 2 ins. A further continuance of this thought is suggested to include bosses, etc.

The factor of safety, possibly more aptly classified under strength considerations, should with equivalent weight of section be higher with either of the web sections. The comparative thinness of the casting allows of ready and careful examination by the inspector. With the rectangular section ofttimes the outer surface covers a multitude of sins, discovered only when failure of a part discloses interior honeycombing. Aside from these, each of which favor the web section, no distinctive advantage seems to exist as to durability between the several sections.

The suggestions as here given are such as appear to the designer. The scope of the discussion might be increased to a consideration of problems as they are presented to others, whose part it is to assist in the production, but such is beyond the scope of this criticism.

G. S. EDMONDS,
Mechanical Engineer, Delaware & Hudson Co.

THE COST OF TRACK SCALES FOR LOCOMOTIVE COAL.

To the Editor:

At the last convention of the Master Mechanics' Association the question was brought up regarding the best methods of saving fuel on locomotives. During the discussion some members of the committee and a number of the members thought it best, if going into this question thoroughly, to locate track scales at each coaling plant, so that the coal could be accurately weighed for each trip.

After reading over the report of the committee and more fully looking into the matter, I began to wonder what it would cost a railroad having a large number of coaling plants and operating from twelve to fifteen hundred locomotives, to place track scales at each of the important coaling plants or engine houses where coal was loaded on tenders.

If we are going thoroughly into this question, taking the committee's advice as to comparing one engine with another doing the same class of work, and one engineman with another, it is absolutely necessary, of course, to weigh the coal, as all enginemen well know that at the present time on the majority of roads the weight of coal is merely guessed at.

On a road of the size just mentioned, say, having in service an average of thirteen hundred engines, it would take at least a single set of track scales at eleven coaling plants and two sets of scales at six more coaling plants, making a total of twenty-three sets of scales to be installed at a cost of about $1,000 each or more per set, making a total expenditure of $23,000 for installing track scales.

After the scales have been installed, in order to get the accurate weight of the coal it will be necessary to have competent men, one by day and one by night, to take charge of each set of scales, which means sixty-four men in all, at a salary of about $54 per month for each man, or a monthly expenditure of $3,456 for weighmasters. Adding the amount expended for track scales, $23,000, to the amount expended in labor at the end of the first year, $41,472, it would amount to a total expenditure of $64,472. At least a saving of 6 per cent. on the $23,000, the cost of installing the track scales, added to the $41,472, the amount of money expended in labor, which would amount to $42,852, would be necessary. This would be equivalent to a saving of 34,281 tons of coal at $1.25 per ton.

I believe that every effort possible should be made to save fuel by keeping the coal picked up at all coaling plants, and not allow tenders to go away from the coal dock that are overloaded, so that the coal will be falling off all along the line of the road for the first twenty-five miles. If the loading of coal is properly looked after at the coaling plants, so that none will be wasted there, or lost off the tenders on the road, and a competent man appointed, to, say, every one hundred engines, as traveling firemen, to educate the men regarding the firing of engines, it will save more coal and black smoke in three months than all the track scales, corps of clerks and expert figuring would save in three years. The old saying is: "Figures will not lie." That may be true, but neither will the figures of a number of weighmasters and a high-salaried office man bring back the coal without an expert fireman putting his hands to the shovel and teaching the men on the road how to use the coal to advantage on a locomotive.

"D."

THE NERNST LAMP.

This lamp appears to be the most important recent development in electric lighting, and it is undoubtedly the most noteworthy exhibit at Buffalo, where it is shown to the public for the first time. There are over 100 400 candle-power Nernst lamps lighting the Westinghouse space in the Electrical Building. There are also several 50 candle-power lamps of the same kind, and also incandescents for comparison. This new lamp seems to be on the arc light order as to strength, and it takes less current than the incandescent.

"Glowers," resembling small diameter wires, of white material and made by a secret process, furnish the light. These are about 1¼ in. long and are placed in a horizontal plane in the lamp. They are in multiple, six being used in the 400 candle-power lamp, and only one in the 50 candle-power lamp. These glowers are non-conductors when cold, and must be heated by exterior means before they will take any current. Each glower is placed directly under a heater coil of fine iron wire, and when these coils are heated by the current the glowers also heat and begin to conduct. The arrangement for heating the glowers and automatically cutting out the heaters is ingenious and important. This is the factor making the lamp possible commercially.

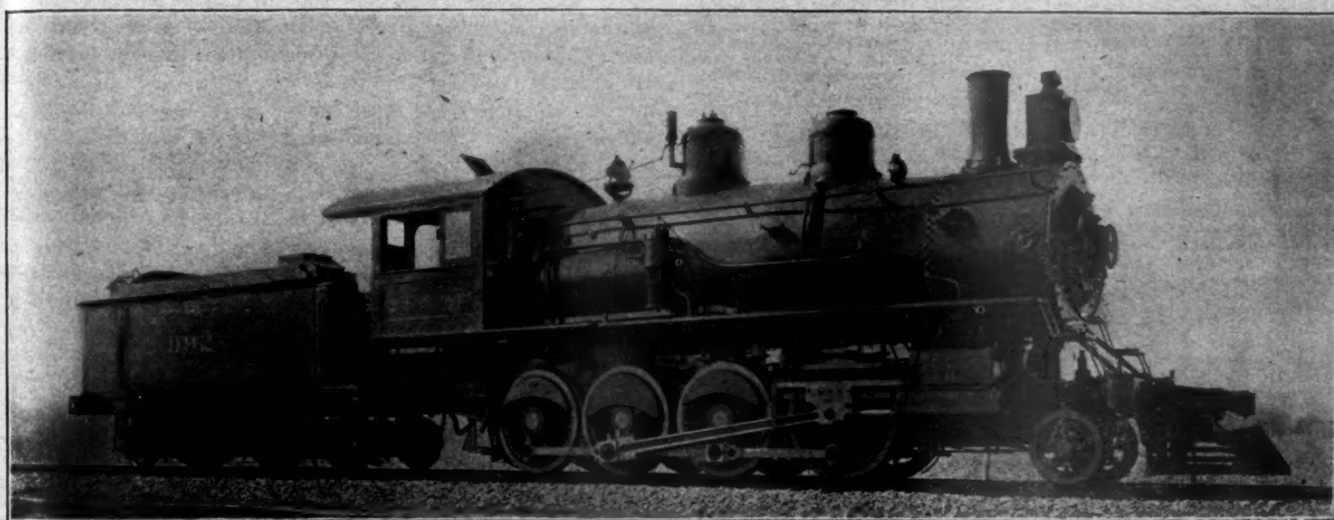
When the current is turned on, the heaters and the glowers are all in multiple, but the glowers take no current because of their high resistance when cold. The heaters rapidly heat the glowers, however, and they soon begin to take some of the current. As the glowers work up toward their full conductivity a magnet, which is in series with them all, cuts the current out of the heaters and the lamp comes up to full candle power, when the glowers take all of the current. This requires about 20 seconds. Another ingenious device completes the lamp. In series with each of the glowers is a coil of iron wire sealed up in a glass tube filled with nitrogen. The purpose of these is to regulate the current through the glowers. When the current increases the iron wires heat and cut down the current to the glowers, and when it drops off the resistance of the iron decreases and the glowers receive more, the action of the iron and the glowers in regard to heat and resistance being opposite; this arrangement acts as a regulator to take care of considerable variations of current.

In the 400 candle-power lamp the glowers are good for about 900 hours and are easily renewed. These lamps will cost more to install than incandescent, but they take much less current and are cheaper to operate. Thus far they have been used with alternating currents only, but there seems to be reason to expect them to work equally well with direct current when further developed. The light is pleasing, and it causes colors to change less than incandescent lights.

CONSOLIDATION MOUNTAIN PUSHING LOCOMOTIVE.

Atchison, Topeka & Santa Fe Railway.

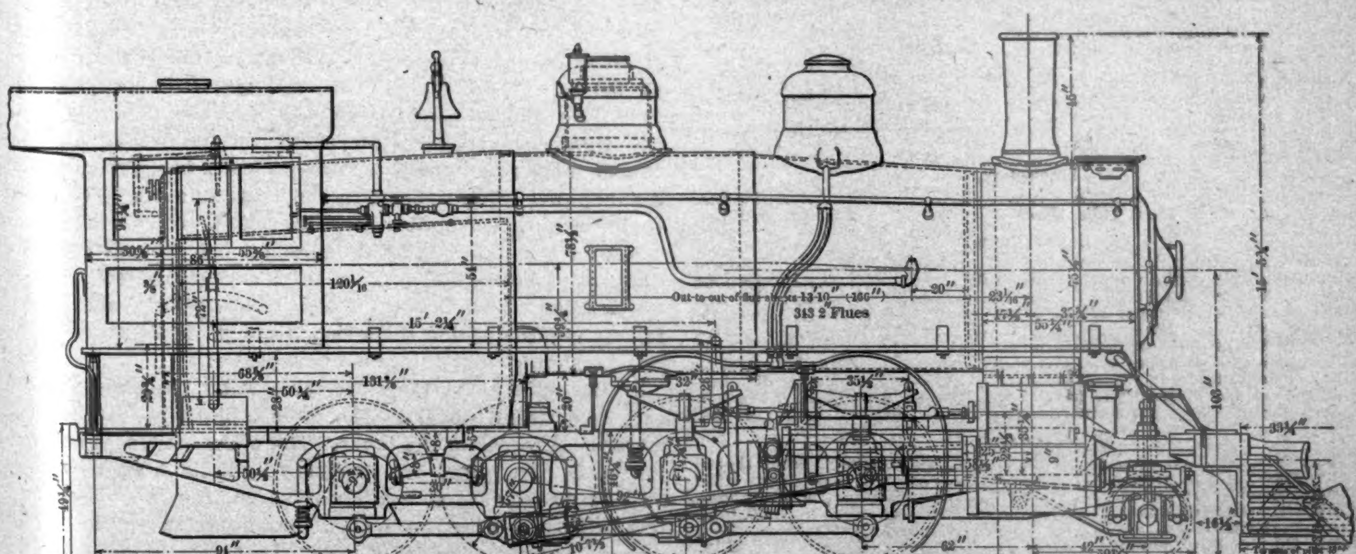
A heavy mountain pushing locomotive with 21 by 32-in. cylinders was designed recently by the motive power department of the Atchison, Topeka & Santa Fe Railway, under the direction of Mr. John Player, Superintendent of Machinery, through whose courtesy we have received a photograph and elevation drawing. Ten of these engines are being built at the Topeka shops and the design appears to be an excellent one for this service. These engines are intended chiefly for pusher service in the Sierras of Arizona and New Mexico. They are simple engines with piston valves, radial stayed boilers and swing motion pony trucks. With 21 by 32-in. cylinders, 57-in. driving wheels and 200 lbs. steam pressure the tractive effort will be 39,000 lbs., and while the heating surface is not large for an engine of this weight it is sufficient to permit of road as well as pushing service. More than usual care was necessary in selecting the proportions of these engines and the distribution of the weight was most carefully figured in order to meet the exacting conditions existing in the territory for which they are intended. Thus far they have come fully up to Mr. Player's expectations. A summary of the leading dimensions is given in the following table:



CONSOLIDATION PUSHING LOCOMOTIVE FOR MOUNTAIN SERVICE—ATCHISON, TOPEKA & SANTA FE RAILWAY.

JOHN PLAYER, *Superintendent of Machinery.* *Built at* TOPEKA SHOPS.

Cylinders: 21 × 32 in. Boiler Pressure....................200 lbs.
Wheel: Driving..........57 in.; engine truck..............30 in.; tender wheels.............................33 in.
Weights: Total of engine..........185,000 lbs.; on drivers..........166,400 lbs.; total engine and tender..............300,000 lbs.
Grate area and tubes: Grate area..............................35 sq. ft. Tubes..................................265 2 in., 13 ft. 10 in. long.
Fire box: Length..........120 in.; width..........40¼ in.; depth of front..........73¼ in.; back..............67¼ in.
Boiler: type..............................radial staying. Diameter..............................72 in.
Heating surface: Tubes..............2,475 sq. ft.; firebox..................224 sq. ft.; total.....................2,699 sq. ft.
Wheel base: Driving..........15 ft. 4 in.; total of engine..............24 ft. engine and tender..............52 ft. 10 in.
Tender: Eight-wheel; water capacity..........6,000 gals.; coal capacity..........10 tons.



Consolidation Pushing Locomotive—Atchison, Topeka & Santa Fe Railway.

Leading Dimensions.

Gauge	4 ft. 8½ ins.
Kind of fuel to be used	Bituminous coal
Weight on trucks	18,600 lbs.
Weight on driving wheels	166,400 lbs.
Weight, total	185,000 lbs.
Weight, tender	115,000 lbs.

General Dimensions.

Wheel base, total of engine	24 ft. 0 in.
Wheel base, driving	15 ft. 4 ins.
Wheel base, total engine and tender	53 ft. 10 ins.
Length over all, engine	39 ft. 4½ ins.
Length over all, total engine and tender	65 ft. 3 ins.
Height, center of boiler above rail	9 ft. 7 ins.
Height of stack above rail	15 ft. 6 ins.
Heating surface, firebox	224 sq. ft.
Heating surface, tubes	2,475 sq. ft.
Heating surface, total	2,699 sq. ft.
Grate area	35 sq. ft.

Wheels and Journals.

Wheels, leading, diameter	30 ins.
Wheels, driving, diameter	57 ins.
Material of wheel centers	Main S. C., others C. I
Type of leading wheels	Radial pony swing truck
Journal leading axles	6½ by 10½ ins.
Journal leading axles, wheel fit	6¼ ins.
Journal driving axles	9 by 10½ ins.
Journal driving axles, wheel fit	9 ins.

Cylinders.

Cylinder diameter	21 ins.
Cylinder stroke	32 ins.
Piston rod diameter	4 ins.
Main rod, length center to center	127½ ins.
Steam ports, length	25¼ ins.
Steam ports, width	1⅝ ins.
Exhaust ports, least area	67 ins.
Bridge width	3 ins.

Valves.

Valves, kind of	Improved piston
Valves, greatest travel	6⅛ ins.
Valves, steam lap (outside)	⅞ in.
Valves, exhaust clearance (inside)	0 in.
Lead in full gear	Line and line

Boiler.

Boiler, type of	Wagon top
Boiler, working pressure	200 lbs.
Boiler, material in barrel	Steel
Boiler, thickness of material in shell	¾-in., ¾-in.
Boiler, thickness in tube sheet	9/16 in.
Boiler, diameter of barrel front	72 ins.
Boiler, diameter of barrel at throat	78½ ins.
Seams, kind of, horizontal	Sextuple
Seams, kind of, circumferential	Double
Crown sheet stayed with	Radial stays
Dome, diameter inside	30 ins.

Firebox.

Firebox, type	Radial stay
Firebox, length	120 ins.
Firebox, width	40¼ ins.
Firebox, depth, front	73¼ ins.
Firebox, depth, back	67¼ ins.
Firebox, material	Steel
Firebox, thickness of sheets	Crown 9/16 in., tube 9/16 in., sides ⅜ in., back ⅜ in.
Firebox, brick arch	On water tubes
Firebox, mud ring, width	4½ ins. all around
Firebox, water space at top	Back 4½ ins., sides 6⅞ ins.
Grates, kind of	Cast iron, rocking
Tubes, number of	345
Tubes, material	Charcoal iron
Tubes, outside	2 ins.
Tubes, thickness	No. 11 B. W. G.
Tubes, length over tube sheets	13 ft. 10 ins.

Smokebox.

Smokebox, diameter, outside	75½ ins.
Smokebox, length from tube sheet	60 13/16 ins.

Other Parts.

Exhaust nozzle, single or double	Single
Exhaust nozzle, variable or permanent	Permanent
Exhaust nozzle, diameter	5¼ ins.
Exhaust nozzle, distance of tip below center of boiler	4½ ins.
Netting, wire or plate	Wire
Netting, size of mesh or perforations	2 by 2 No. 11
Stack, straight or taper	Cast iron, taper
Stack, least diameter	15⅜ ins.
Stack, greatest diameter	18⅜ ins.
Stack, height above smokebox	45 ins.

Tender.

Type	Eight-wheel, steel frame
Tank, type	Gravity slide
Tank, capacity for water	6,000 gallons
Tank, capacity for coal	10 tons
Tank, material	Steel
Tank, thickness of sheets	¼ in. and 5/16 in.
Type of under frame	Steel channel
Type of trucks	Player S. C.
Type of springs	Double elliptical
Diameter of wheels	33 ins.
Diameter and length of journals	5 ins. by 9 ins.
Distance between centers of journals	62 ins.
Diameter of wheel fit on axle	6⅜ ins.
Diameter of center of axle	5⅜ ins.
Length of tender over bumper beams	23 ft. 10½ ins.
Length of tank inside	22 ft. 3 ins.
Width of tank inside	9 ft. 6 ins.
Height of tank, not including collar	5 ft. 0 ins.
Type of draw gear	M. C. B. coupler

Special Equipment.

Brakes	American for drivers, Westinghouse for tender and train service
Pump	9½ ins.
Sight-feed lubricator	Double Nathan
Safety valves	Three 3½-in. Crosby
Injectors	Two No. 10 simplex
Metallic packing, piston rods	Jerome

THE "PAN-AMERICAN."

The originators and executors of the plan of this exposition are entitled to a great deal of credit. The surroundings have a significance of their own which is deeper than that of a mere housing of the exhibits. Harmony is the underlying idea of the plan, and unusual attention has been given to detail. An impression is conveyed to the effect that our remarkable commercial development has not entirely divorced art from industry, and the beauty and grace of the combination are significant of a higher and purer ideal than that of commercial supremacy. It must exert a powerful moral influence, and even those who do not see beyond the mere exposition features cannot fail to be better for having visited it.

It is broadly and distinctively American, and presents a thoughtful record of the social, political and commercial development of this continent. It was not necessary to borrow even the architecture of older countries, and the harmony with which the work of numbers of individuals was perfected to accord with a single underlying idea is admirable. Nothing like it has ever been accomplished before and the whole scheme seems to promise greater things for the future.

The grounds should be approached from the park at the south, and the first near view should be taken from the bridge. From this point begins a scene of beauty, combining architectural, landscape, color and sculptural effects, all of which are loyal to the original conception of a harmonious whole with a most satisfactory result. Instead of uncovering crudities, close study developed the details, which are carried out faithfully and thoughtfully. A trip on the waterway reveals many features and effects which cannot be seen in any other way. It should be taken by day and again at night.

At night the most impressive effect is produced. The lighting scheme is not less artistic than the rest. The idea of the architecture is harmony, and that of the lighting is proportion. This may be understood by comparing the heights of the buildings and noting the treatment of the lights. To Mr. H. Rustin, Chief of the Mechanical and Electrical Bureau, belongs the credit of the illumination and the fascinating effect produced by the slow "turning on" of all the lights simultaneously all over the grounds at the beginning of darkness. Usually all of the eight candle-power lamps take current from Niagara, twenty miles away and these are gradually brought up to full candle power from darkness in about two minutes. They soon begin to glow perceptibly, and the effect of the gradual increase of the light until the buildings and grounds are fully illuminated by the soft light of the low candle power lamps is worth going a long distance to see. It is wonderful and beautiful. A glimpse behind the scenes, through the courtesy of Mr. Rustin, showed how this was accomplished.

At the cable house there are three water rheostats, one for each cable from Niagara. The three cables terminate in submerged electrodes in the tanks. The other electrodes are vertical plates supported at one corner by a shaft whereby they may be dipped into or entirely removed from the water, and this is accomplished by a small motor acting on the plates through worms and worm wheels. At the beginning of the illumination these removable plates are raised almost entirely out of the water, the resistance being great enough to render the lights non-luminous. The motor is then started and the plates are dipped slowly into the water without commotion beyond a lively sparking at the surface of the water. In their lowest position the movable electrodes rest in contact with the others and the lights then run at full candle power. This current is at 10,500 volts and the load is 3,730 kilowatts, which gives an idea of the boldness of this plan. An afternoon spent in the vicinity of this heavy current inspired a high degree of respect for it. It is rather impressive to see a copper cable of 300,000 circular mils burn out like a piece of fuse. From the rheostat the cables run to the General Electric transformers in

the Electricity Building, where the currents are handled by oil switches until stepped down for the lighting circuits. The extent of the lighting feature made possible by the Niagara power, is likely to be a high watermark in this direction for some time.

The Exhibits.

While the success of the Exposition does not rest entirely with the exhibits they are by no means uninteresting. Machine tools are well represented, particularly automatic and semi-automatic machinery. Many of the exhibits are running, and these merit specially careful examination. Gas and oil engines take a more prominent place than ever before in an American show, with a promise of a most important future. Large engineering work is represented by one of the Worthington condenser and air-pump units for the Manhattan Railway power house in New York. The electric manufacturing concerns content themselves with a display of apparatus, the entire Exposition being prominently an electric exhibit. The Bullock Electric Manufacturing Company have a number of generators, motors and transformers, well arranged and carefully exhibited. In the Westinghouse exhibit are two gas engines, one small one and the other of 300 horse-power, direct-connected to generator and using natural gas. In this exhibit is—to many people the most noteworthy feature of the entire Exposition—the Nernst lamp, which is described elsewhere in this issue. Taken as a whole the Westinghouse apparatus was exceedingly prominent, including the gas engines, electrical machinery, air brake, electric brake, friction buffer and electric and electro-pneumatic signaling, each appropriately shown and in nearly every case in actual operation.

The General Electric Company had an impressive exhibit, especially that used in connection with the Niagara supply of power to the Exposition.

Edison's new storage battery, which, by the way, has been withdrawn from competition, attracted a great deal of interested attention. It is not in operation, but Mr. Edison promises to take others to the exhibit which will be complete and in operation. The capacity of the one shown is ⅛ h.p. and 100 ampere-hours, its weight being but 5¾ lbs.

Of twelve locomotives exhibited only two have narrow fireboxes between the frames. The powerful passenger engines of the past year were represented by one of the Lake Shore & Michigan Southern prairie type, the "Chautauqua" type of the Brooks works, the "Central Atlantic" type of the New York Central and Michigan Central, and the Vanderbilt engine and tender of the Illinois Central. These were accompanied by the Schenectady 8-wheel passenger engines for the D., L. & W., the compound consolidated engines with wide firebox for the New York Central, the Richmond compound No. 2,427, and two Baldwin consolidation freight engines. Unfortunately these locomotives are all crowded into an entirely inadequate space, where they do not appear advantageously, although they attract a great deal of attention. The Lake Shore engine bears the following worthy inscription: "Most efficient per unit of weight and lightest per unit of power ever constructed."

No such array of powerful passenger locomotives has ever been assembled before, and had they been given the entire space in the terminal station annex they would have been considered one of the leading features of the Exposition. The enormous increase of recent years in boiler capacity is very impressive as represented in this exhibit. There is not the least suggestion of a freak in the lot; each engine represents the development of the locomotive along well understood lines toward the ultimate possibility within the prescribed limits of size and weight.

Our readers will also be interested to see the Gould electric car lighting system of the Gould Coupler Company, which is in operation with a complete equipment. Near it are the exhibits of the Simplex Railway Appliance Company, the Continuous Rail Joint Company of America, that of O. M. Edwards' car windows, the new "Major" coupler of the Buckeye Malleable Iron & Coupler Company and that of the Standard steel wheels. The car exhibited by the J. G. Brill Company we have already described. In this department there is an attractive exhibit by the Safety Car Heating & Lighting Company.

In the machinery building on the main floor are a number of gas engines by the Otto Gas Engine Company, of Philadelphia, and also an exhibit by Mietz & Weiss, of New York. In the inner court of this building are the steam engine and other gas engine exhibits. These are likely to be missed unless the visitor is looking specially for them. The gas engines are particularly interesting and some are of considerable power, indicating substantial progress. The National Meter Company, of New York; the Alberger Company, of Buffalo; the Bessemer Gas Engine Company, Grove City, Pa.; Struthers, Wells & Co., Warren, Pa., and the Marinette Iron Works, of Marinette, Wis., are the principal exhibitors.

Struthers, Wells & Co. show a large vertical twin-cylinder engine with 21 by 24-in. cylinders, a single heavy flywheel and a very heavy bed. This engine is started by air compressed by an auxiliary pump. The attendant stated that this engine was operating with less than 10 cu. ft. of gas per net horse-power per hour. A 125-h.p. four-cycle, two-cylinder tandem gas engine is exhibited by the Alberger Company. This engine has electric ignition with adjustable timing to give variable lead. In starting, the valves are blind and the lead increases to the desired extent as the normal speed is reached. We did not see this engine running. The valves are operating positively and the governor regulates the amount of charge instead of by the "hit or miss" principle. A large standard type of Nash engine is shown by the National Metal Company. It has three vertical cylinders and is rated at 125 horse-power.

In machine tools we found a number of new developments in the form of automatic machinery and in the methods of driving. The cone pulley and inconvenient change gear are giving place to gears in nests, with convenient methods of couplings for the desired speed without the bother of shifting belts. The machine tool exhibits are briefly described in another column.

There are many other interesting exhibits, for example, the Carborundum Company and the Wm. Powell Company, but for the time we must be content to mention these. It is fitting and pleasing that the best and most complete and finished exhibit of all is that of the various departments of the United States Government.

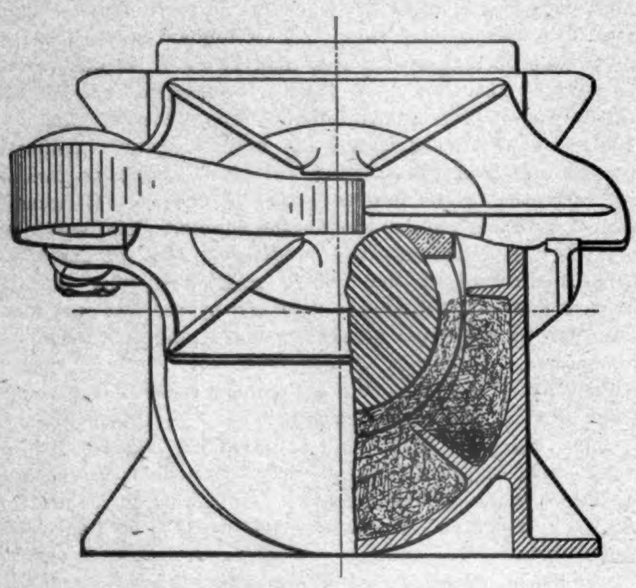
Mr. F. W. Johnstone, Superintendent of Motive Power and Machinery of the Mexican Central Railway, has resigned to devote his entire attention to private interests in Mexico City. Mr. Johnstone has had a successful railroad experience which dates as far back as April, 1874. Since that time he has been connected with the Philadelphia, Wilmington & Baltimore, Panama, Springfield, Jackson & Pomeroy and Mexican Central Railroads, working through the positions of draftsman, machinist, foreman, assistant master mechanic and master mechanic. The latter position he held with the Springfield, Jackson & Pomeroy from 1879 to 1881, when he went to the Mexican Central in the same capacity. In 1884 he was appointed Superintendent of Motive Power and Machinery of the entire system and in this capacity he has served up to the present time. Mr. Johnstone will on the appointment of his successor open a consulting engineer's office in Mexico City, and will be associated with Mr. Rafael M. de Arozarena, under the firm name of Johnstone & Arozarena, Consulting Engineers. Mr. Arozarena is an American by birth, who has been in this country nearly twenty years. Both Mr. Johnstone and Mr. Arozarena have a wide acquaintance in the Republic of Mexico, and will be glad to serve their friends in the United States who may desire any technical information concerning Mexico.

AN IMPROVEMENT IN JOURNAL BOXES.

Recently a great deal of trouble has been found on some railroads on account of the waste getting caught between the brass and the journal, and Mr. T. H. Symington has added to his journal boxes two ribs just above the center line of the journal, as shown in the accompanying engraving.

It is quite difficult to get the every-day inspector to pack boxes properly and get enough waste on the sides of the journal without getting it too high; these upper ribs in combination with the ribs for supporting the packing and oil on the sides enable the inspector to put the waste exactly where it is wanted and absolutely prevent his getting the waste too high on the sides. After the box is packed these ribs also prevent the waste on the sides of the journal from rolling up with the journal and getting caught beneath the brass, producing what is usually known as a waste grab.

In the discussion at the Master Car Builders' Convention on the subject of standards, Mr. Rhodes remarked that he thought the round bottom box was wrong construction, as it was his experience that after a run of 100 to 150 miles the waste had all rolled up on one side in the direction in which the journal was revolving, and that what these boxes then needed was not oil but attention. He further said that he thought we should have a standard box with the bottom so shaped that it would hold the waste in position.



An Improvement in Journal Boxes.

Mr. Symington is satisfied from his own observation that the waste does not slide on the bottom of the box at all. He believes it is simply the top part of the packing that is in contact with the journal that rolls on the bottom part of the packing, and the shape of the bottom of the box has really nothing to do with it. The ribs, as shown, entirely prevent this movement of the packing in contact with the moving journal, and by their use it is thought to be impossible for an inspector to pack a box improperly.

General Superintendent J. M. Wallis, of the Pittsburgh Division of the Pennsylvania Railroad, has granted an increase in wages to the engineers of the larger locomotives. The low-rate day has been advanced from $3.50 to $3.70, and the high-rate day has been advanced from $4.10 to $4.35. The high-rate day is a run from Altoona to Pitcairn, and a low-rate day is only a partial trip. Under the new arrangement the engineers' time is to be counted from the minute they report until they are relieved.—"Railway and Locomotive Engineering."

SOME DETAILS OF FUEL OIL BURNERS.

Oil fuel has thus far had a relatively small application to locomotive service, and with the exception of a very few roads it has not been systematically employed. The recent developments of the Texas oil region seem likely to greatly extend its field and render information concerning the details of oil burning interesting in a much larger territory. At a recent meeting of the Pacific Coast Railway Club Mr. W. N. Best recorded his experience, from which the following paragraphs are taken:

If we will first consider the burning of bituminous coal, we can better understand the subject of using crude oil, or liquid fuel, for it is very important in both cases that the volatile gases should be properly consumed, as they contain remarkably high heat-producing qualities. Average bituminous coal contains about 65 per cent. of carbon, which has the same heat-generating qualities as coke, and 25 per cent. of hydro-carbons, which are of the nature of illuminating gases. About one-quarter, by weight, of the hydro-carbons is hydrogen gas, which makes the hottest fire possible, but a very high temperature is required to burn this gas, and if, from any cause, parts of the firebox become too cold for converting gas into flame, it passes away unconsumed in the form of smoke or worthless uncombined gas, and makes no more heat than superfluous air.

The loss from permitting hydro-carbon gases to pass away is two-fold; in the first place, the heat of the burning carbon has been wasted in distilling the gas from the coal, and in the second place, valuable heat-making gases have been wasted.

The combustion of one pound of hydrogen gas, if it combines with all the oxygen of the air necessary to effect perfect combustion, produces 62,000 heat units, or enough to raise about 365 lbs. of water from a tank temperature to the boiling point. The complete combustion of one pound of carbon, such as rests on the grates, after the volatile gases have been liberated, produces heat sufficient to raise about 85 lbs. of water from the tank temperature to the boiling point.

I give these figures to show how important it is to have all the volatile gases properly burned, and to bring us to realize the importance of always keeping every part of the firebox up to what is called "the igniting temperature."

I claim that it is very much easier to make perfect combustion in oil-burning locomotives than by the improved methods of burning coal. First, it is necessary to have a good burner that will atomize the oil perfectly by the steam jet striking the flow of oil from the burner, so that the point of ignition will not exceed 8 ins. from the mouth of the burner, and completely fill the firebox with flames, thereby producing and maintaining a temperature sufficient to ignite the hydro-carbon gas as well as the other gases and distribute the air which is admitted through the holes in an inverted arch to cause perfect combustion, the quantity of air admitted being regulated by dampers on each end of the ashpan.

I find that some of the hydro-carbon burners used on locomotives are entirely incapable of securing desirable results and ruin the metal of the firebox by the force of flame, similar to a flame made by a blow pipe. My attention was first called to a burner of this type some years past. By placing it under a stationary boiler the result was that the igniting point of oil was almost at the first bridge wall. The flame passing under the boiler, then through the 3-in. flues in the boiler, thence up through the smokestack, made the smokestack red with almost melting heat, when I was compelled to change it for another type of burner. You can well imagine what great injury this style of burner would do to the crown bar bolts and flues and heads of rivets that rivet the crownsheets to side sheets in the firebox. The cold air is forced into the rear of the firebox, and often a burner of this type will prove a failure, and a locomotive will smoke in spite of any efforts made by skilled and attentive firemen, and in a short time a new firebox will be required, which means unnecessary expense and creates a prejudice in the minds of many against crude oil as fuel.

This has been especially noticeable in oil-burning locomotives, for the reason that the forced intermittent draft, caused by the exhaust of the locomotive, carries air into the firebox in largely varying quantities, thus at one moment tending to chill the firebox and the contained gases and carrying a portion of them off as smoke, and at the next moment allowing certain gases to suddenly ignite and be carried through the lower flue, often resulting in a series of explosions of greater or less force, and causing injury to the lower flues by reason of unequal distribution of the heat, which causes the beads of the lower flues to become spongy and burn off, thereby causing the flues to leak.

By use of a proper atomizer the nose piece can be released from its position by the operation of a bridle. Should any scale from pipe or boiler pass into the atomizer channel, in 30 seconds it can be removed by simply uncoupling the bridle, a point I consider of great value, as it insures the best results without delay. The atomizer is also provided with an automatic condensed steam release valve, which, by means of a spiral spring, is raised from its seat, which allows the condensed steam to pass out, and when the steam is turned on the burner, the pressure of the steam closes this valve. This device prevents water from injuring the refractory walls and arch.

I use an inverted arch, similar to those used in Russia and South America, and by railroads of California and Arizona, with this exception, that the hole for the admission of air is immediately back of the front refractory wall, for these reasons:

By numerous experiments I found that this gives the best results, as the air is admitted at the wall against which the current of flame is forced, and the oxygen of the air is mixed with the volatile gases as the flames rise and pass under the refractory arch into the upper portion of the firebox. Several roads use three air cavities in the inverted arch, the two rear ones merely allowing the currents of cold air to pass up by the side sheets, which chills the firebox and escapes with the hydrogen gas out from the smokestack, the very gas of all gases which should be saved.

The inverted arch is lined with firebrick at the rear, and around the air cavity angle iron is riveted in order to hold the firebricks intact. The refractory arch consists of bricks especially designed, 9 ins. thick, fitting closely to the front refractory wall and resting upon two refractory wedges, which gives them the proper pitch, the highest portion of the arch being on an exact level with the lower flue. This arch is one-third the length of the firebox.

When I took charge of the machinery department of the Los Angeles Terminal Railway, July 17, 1899, I found the locomotives in a very bad condition, especially the fireboxes and flues. To see an engine coming at a distance, not knowing that it was burning oil, you would have imagined that it was an old style coal burner, by the amount of volatile gases escaping from the smokestack. By examination of the fireboxes I found that the same grates and grate frames were used as when engine was burning coal, the air being admitted through the grate. The arch extended from flue sheet to fully one-half the length of the firebox; the arch consisted of 66 firebricks, which required a man five hours to build, and I am informed that often a portion of them would fall down before making a 30-mile run. One by one I took the engines into the shop and equipped them with an inverted arch, refractory wall and an arch as described.

I immediately instituted a night school of instruction for the enginemen, in order that they might fully understand the proper handling of oil. At first, very few were in accord with my ideas; they imagined that if the engine did not make smoke it would indicate that too much air was being admitted in the firebox, which would certainly cause the flues and stay bolts to leak. One evening I opened the front end of an engine that had not been changed in order to show the condition of the flues. I also ascertained the amount of sand that had been used to clean the flues that day, which was an astonishing amount. The 2-in. flues were almost filled with flaked soot; the holes through the flues would not exceed ¾ in.

The following is a comparison of the engine and car mileage and barrels of oil consumed by the old method of the Los Angeles Terminal Railway, as compared with the present method, showing the results by the saving of gases:

July, 1899—Engine mileage	20,364
Car mileage	67,016
Barrels of oil consumed to do the work	3,050
Cost per mile for repairs	.0555
July, 1900—Engine mileage	21,628
Car mileage	73,881
Barrels of oil consumed	3,331¼
Cost per mile for repairs	.0222

The tonnage was very much greater in July, 1900, than in July, 1899, thus making a saving of about one-third fuel oil. Thus it is seen that these valuable results come from a proper handling of the fuel oil.

On every division there should be a competent engineman, acquainted with all the grades of the division, whose duty it should be to instruct the enginemen to properly handle the oil, and at the end of every month report to instructor on combustion the name of the crew making the best record in oil saving, and due recognition by the superintendent to be given them. The burning of crude oil should not be even as injurious to the metal of a firebox as bituminous coal, for a more even heat can be attained and controlled. The cavities for admission of air in order to supply the necessary oxygen, should be carefully examined, so that they will not fill with pieces of broken firebrick.

The crude oil of 15 to 18 gravity gives the best result; is not explosive should a wreck occur, and should be as free from water as possible, as water is well known to be injurious to the refractory walls and arch.

When we first began the use of oil in locomotives in this part of the State, early in 1895, we used coils in the oil tank for the purpose of heating the oil. This was found to be a failure for these reasons: Oil of 16 gravity must be heated, and when a supply of oil was given the engine the process of heating the oil by coils was found to be too slow. A heater pipe, allowing live steam to mingle with and heat the oil, at a point near the flange connection of the oil tank which connects oil tank with burner, has been found to obtain desired results.

In conclusion, allow me to say that I confidently believe that within six months the present method of burning crude oil will be revolutionized by a new and better system, giving in every way more satisfactory results.

Mr. Best's Apparatus.

This discussion may be more easily understood by an examination of the accompanying engraving showing the apparatus referred to. Instead of the usual arrangement, the oil orifice of this burner is below the stem opening. In order to guard against clogging the burner the nozzle may be easily opened for cleaning. At the back end of the burner an automatic drainage cock is fitted to prevent an accumulation of condensed steam in the nozzle when the steam valve is closed. If water should be thrown against the brick arch when hot it would suffer considerable damage.

In the firebox an inverted arch is placed. It has an opening for air back of the front firebrick wall, this having been decided upon by experiment. The arch is lined with firebrick where the flame reaches it and it is bound with angles to prevent it from breaking down. These bricks are 9 ins. thick and made specially for this purpose. The location of the arch with reference to the flues and its length are indicated in a general way in the drawings.

The oil is carried in a tank in the coal space of the tender and flows by gravity to the burner. In passing from the tank into the delivery pipe, the oil goes through a cast iron well under the tank, where it is heated by steam from the boiler. This device insures a continuous and ready supply of heated

oil to the burner by heating it only as it is used. This well also traps the water that may be in the oil before it goes to the burner.

Test on the International & Great Northern.

Mr. W. B. Chenoweth, Mechanical Engineer of this road, has kindly sent us the following communication on this subject:

"The fuel oil question in Texas is becoming very interesting. I give, below, the performance of an 85-ton engine with 20 by 28-inch cylinders, which has been in service the past two weeks and is equipped with the W. N. Best oil burning system, using Beaumont oil. This engine makes a 308-mile run and the average coal consumed was 17¾ tons, or 35,500 lbs.; this means 17 1/5 miles per ton of coal. On the same run with the same tonnage the engine is now making the 308 miles on 17,640 lbs. of oil, a difference of 17,860 lbs. in favor of oil. According to Rankine, the well-known authority, the perfect combustion of 1 lb. of bituminous coal is equal to 15,887 heat units. The perfect combustion of 1 lb. of crude oil equals 21,735 heat units, which shows the great advantage of oil over coal.

With this engine the question was not how much steam could be made, but how much steam could be used. The engine carries 200-lb. boiler pressure and could be maintained at that pressure under any and all conditions on the trip. In going up 1 per cent. grade with a 3 deg. curve with 900 tons of freight the engine could be easily poped off while both injectors were working. There was absolutely no smoke and no odor arising from the burning oil, all the smoke being consumed.

It is argued by some that the intense heat will shorten the life of the firebox; but such arguments are not borne out in experience, because it is not the heat that injures the firebox; it is cold air, and with the use of oil the fire door is never opened.

A slight accident to the Brooklyn Bridge occurred July 24. Two of the cables and seven of the short suspension rods at the center of the bridge broke, but without any damage resulting. At the center of the bridge the suspension rods are short, and to accommodate the necessary movement of the roadway in expanding and contracting, trunnion blocks were used at their lower ends. These were so located as to be impossible to inspect and the breakage of the first rod at one of these ends was not discovered until a number had given way. These short rods are subjected to considerable movement in extremely hot or cold weather and the hot days before the discovery probably played a part in the breakage. There was no cause for alarm or for fear of disaster to the structure but no time should be lost to improve the defective details which gave the trouble.

REQUIREMENTS OF ELECTRICITY IN MANUFACTURING WORK.

By William S. Aldrich.

From a paper read before the American Society of Mechanical Engineers.

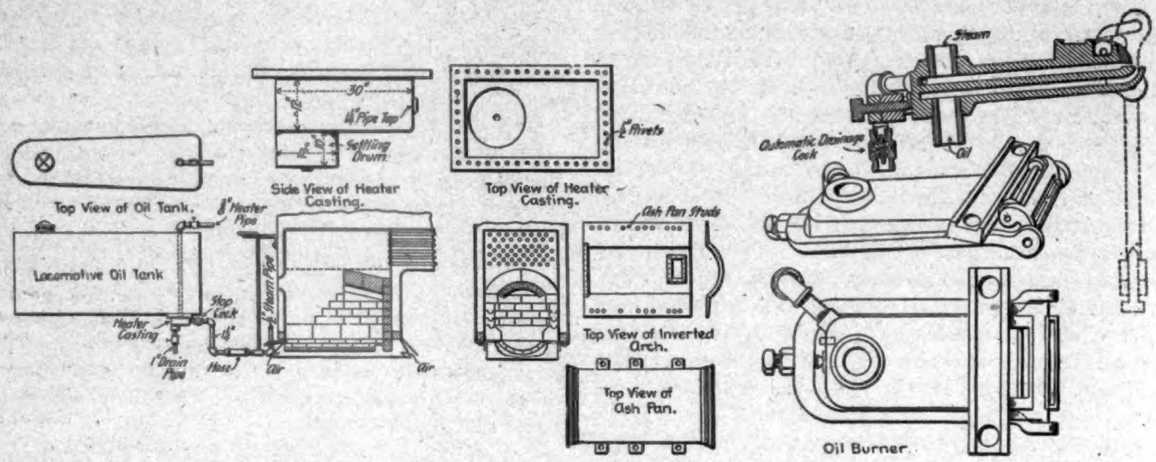
Factories are not built in a day, but the ready extension of existing electrical supply service has increased the output from 30 to 40 per cent. per square foot of floor space. New machines and tools cannot always be obtained on telegraph order, but a resort to electric driving has increased the output of existing machines from 20 to 60 per cent. Workmen may not be had for the asking, but giving them electric-driven machines has increased the output per man from 10 to 30 per cent. All of this has been developed without any strikes or other than satisfactory regulation of wages by recognized premium and price-rate systems.

It is no longer a question of the efficiency of electricity vs. shafting for power transmission. Nor is it a mere question of saving at the coal pile when only 2 or 3 per cent. of the total cost of production is to be charged to the fuel account. In many cases electricity has effected a saving during the first year that has more than paid for the change to the new system. Whether it is more or less economical than mechanical transmission depends upon circumstances. When properly installed and operated, electricity should have inherently all of the considerations in its favor.

The disciplinary value of electric driving cannot be ignored. The old easy-going belt system used to allow many a glance at the morning news, many a familiar chat during long and deep cuts. With the electric drive the operator finds it very convenient to be near his machine. The customary warning signals of slipping belts are no longer heard.

Satisfactory illumination should also be provided. No one will work by a smoky torch when he can have an arc or an incandescent lamp. Electric light must be supplied in these times in all shops where they make a practice of doing a day's work the year round. Only a little wiring is required, and a small amount of extra power is necessary at the generating plant to drive machines and tools by electricity. In many instances electric lighting has paved the way for electric driving.

This system admits of centralized or concentrated power generation, which is required for maximum economy. Distributed power generation in small and scattered units is very wasteful. The electric power plant may be located to best advantage for fuel and water supplies, conveying and transportation facilities. It may be isolated from other structures, so reducing fire risks and insurance rates, especially where the boiler house is in a separate building. The electric generating sets may be subdivided into similar and independent units. These may be operated at all times under the most economic condition of normal loads. This permits manufacturing work in any branch or section of the establishment as economically under part load as under full load, on overtime and night shifts as during the day's work. Electric light may be supplied from the power mains or from separate generators, as conditions require. In



Apparatus for Burning Crude Oil—Los Angeles Terminal Railway.

not a few cases of the introduction of electric driving the additional saving has been more than enough to pay for all of the lighting service.

The distances are short in factory service, the electric distribution being within one building or a group of buildings. The so-called line losses are therefore usually negligible in well-designed installations. Low voltages are employed in factory transmission. From 110 to 550 volts are the accepted limits at the present time in this country, either for direct- or alternating-current working at constant potential or pressure. The economics of the various systems can be only satisfactorily discussed with reference to any given project or installation.

The following are recognized methods of distribution, for electric light or power, or both, in manufacturing work:

Two-wire and three-wire systems, for direct or alternating currents. Multi-circuit system for direct-current multi-voltage service. Single-phase, two-wire alternating current. Two-phase, three- or four-wire alternating current. Three-phase, three- or four-wire alternating current. Composite system, direct current and single-phase or two-phase alternating current on the same wires.

The design, plan, and arrangement of manufacturing establishments are not now dictated or controlled by the new electric transmission, as always has been the case with the old mechanical system. Factory and mill construction is undergoing radical changes incident to the electric transmission of power. There is now a superior adaptation of the building to manufacturing work and sanitary requirements, with higher ceilings for light, ventilation, and overhead transportation. The cost of buildings is reduced to a minimum.

The site for buildings may be chosen independent of power considerations and located on most suitable ground. There is no necessity for buildings being placed around or adjacent to the power-house, as required for mechanical connections to engines or turbines. Grouped shops may be arranged in best manner to facilitate economic production and the handling, conveying, and transportation of material and work. Detached buildings, a tendency of certain lines of modern manufacturing development, are feasible, and the work therein facilitated by electric transmission. The isolation of various shops, departments, and workrooms for manufacturing or insurance reasons may be carried to any extent with the electric system without impairing its efficiency or economy. The output per square foot of floor space is a maximum with electric transmission.

Future areas of work may be planned and arranged for with the utmost freedom and entirely irrespective of power considerations. They can be located as desired, on separate floors, in various departments or in detached buildings. Original provision for prospective development is not necessary in the electric system, but is required by shafting transmission. There is no expense for contemplated additions till they are actually installed as required.

Temporary extensions, to meet sudden demands for power at any point, are quickly made by running to the desired location electric wires or cables. These are easily removed when no longer required and as readily used elsewhere for similar purposes. The shifts are made with the least expense of time and labor in handling, and with no accompanying waste of material to suit different conditions. Auxiliary power is always at hand for emergencies and to almost any reasonable extent, on account of the reserve nature of the electric supply.

When alterations or additions in power transmission are required, it is the invariable practice in many modern shops to extend in the line of electric driving. This is notably the rule where electric supply is already at hand for either lighting or power service. In the rehabilitation of an old establishment some of the shafting transmission may usually be combined with the electric drive, as in the so-called group system. Much can be done to improve the power transmission if existing lines of shafting are divided into the most economic sectional lengths, determined by the speed, character of load, and kind of work.

For individual driving without intermediate gearing the armature of the motor is mounted on the main spindle of the machine. The power is most directly applied, with ideal adaptation of tool to work. It requires more or less special adaptation of motor to machine, with rarely any marked changes in the structural design of the latter.

For individual driving with intermediate gearing the motor is conveniently mounted on the frame of the machine and drives it through the intervention of the ordinary gearing. It requires no special adaptation of motor to machine. Any suitable motor may be used on any machine.

With the individual drive the workman has the most perfect control of all factors entering into the economics of production. There is maximum economy in the application of power. The speed control and the output are independent of any other machine. They are no longer limited by the speed of the line shafting. Machines and tools may now be worked to the limits of their respective capacities. The productive efficiency of the machine is increased. It may be operated at all times up to the power limit, reducing time and cost of labor for any given product. The choice of the individual drive depends upon the power required, the size of the machine, the time it is in service, and the value of the product. The individual motor drive is usually adopted where the machine is in use only part of the time, and in sizes as small as two or three horse-power, and requiring wide variations in speed and power for maximum output, quite independent of the first cost. For large machines this method reduces the power losses to a minimum. It is particularly advantageous for shears, punches, and a class of repair shop tools requiring power only at intervals. The constructive details and design of direct-driven machines are not usually altered to any extent; secondary speed changes are obtained by the usual change-gear and mechanism; in special cases of large tools, a range of speeds is sometimes best provided by a special variable-speed motor.

In group driving a few large electric motors are employed, independently driving sections of shafting of most economical length. This method is thus adapted for driving a number of small machines, with no particular requirements in speed or in power; or for most economical manufacturing along special lines; or for driving any section on overtime or night shifts; or for independent driving of separate floors, departments, or detached buildings.

The maximum economy with the group system can only be secured when all of the machines so driven are in constant use, at best speeds for maximum output. This dictates grouping machines as far as practicable of the same size, style, functions, speed and power requirements, having due regard to the work to be executed. Sectionalizing the power transmission by substituting electric motors for either the main or section belts secures partial advantages of the new system side by side with the old, and is frequently resorted to in old establishments adopting new methods.

The most general requirements of factory transmission can all be met by an intelligent combination of individual and group driving. The first cost of installing the individual drive will generally be from 2 to 5 per cent. higher than for the best group system, when all other considerations are the same. The individual drive is more economical in the use of power than the group system, especially if in the latter only a limited number of grouped machines are in use at any one time, at average loads.

The extreme flexibility of the electric system invites the widest use of portable tools and appliances. A flexible heavily-armored cable gives any desirable radius of action, with no expense to maintain as a part of the transmission system, with no danger or difficulty in handling, and requiring least time and labor for any immediate shifting of tool or work. Least used tools need not occupy floor space when not in operation. Most favorable economic relations may, therefore, be secured in many lines of manufacturing work, especially of the heavier grades. Almost all required tools may be taken to and operated at the work in hand. Time is saved in not having to shift and adjust the work to the machine or tool. Several operations may be carried on at one time by bringing different tools to the work, each independently driven and operated.

In general, the following lines of inquiry should be freely investigated before choosing any system for power transmission in manufacturing work: The size of the establishment; the area to be served; the arrangement and grouping of shops, departments or buildings; the arrangement, types, and sizes of machines or tools to be driven; the variety of speeds required; the character of the loads involved; the kind of work to be executed; the economics of fuel and water supplies.

It should be possible to drive similar apparatus and motors from any point of attachment to the wiring system. Greater flexibility is thereby secured, added facilities provided for use

of portable tools, and readiest extension made of plant and distributing system at any time. Preferably have one, and only one, electric system if it can be secured by intelligent consideration of all present and the most probable future requirements. This does not necessarily imply that it is best to have one single circuit for all kinds of service required in a manufacturing establishment, as light and power; but it should not be required to use different circuits for the same service, as portable tools.

Generating sets and motor equipments should be standardized as far as possible in the case of any given establishment. These machines, as well as all their parts, should be readily obtained in duplicate at any time. This is particularly important in making additions and extensions in the group system. Electrical machinery to-day is so far standardized, and its performance predetermined, that there can be no excuse for not selecting that style and type best adapted to any given factory.

The load diagram for any machine will furnish the best data for determining the proper size of motor. It may be readily obtained under the working conditions of the machine by using a test motor.

The limit of overload is fixed by the allowable rise of temperature, and can readily be predetermined for any given electric motor. In general, the surface temperature of the motor field coils, as measured by a thermometer, should not exceed from 35 to 45 degrees C., with a maximum limit of 50 degrees C. after an overload run of from six to eighteen hours, as may be specified by the builders.

Starting load currents are of course high, and may be from two to three times the normal current, as in the case of overloads, for brief periods. Individual drives require proportionately larger motors to enable them to carry alone the heavy overloads. Group drives require only normal load motors, as it will rarely ever occur that the several grouped machines are all carrying overloads at the same instant. Motors for this service may often be much smaller than would be dictated by the combined load diagram of the machines forming the given group or section. In no case will they require to approach the maximum, or the sum of the maximum, loads of the various machines.

The speeds should be predetermined by the conditions for most economic maximum output, and so fix the range required for the electric motors. In no instance should the reverse be the case. In many cases of individual drives it may be best to secure the speed reductions mechanically, as by the ordinary change-gear. It is not necessary nor advisable in all cases to secure the same by mounting the motor armature directly on the spindle of the machine. Provide motors with speeds consistent with the range of change-gear, and gear down rather than up.

The actual normal capacity of the generator will be chiefly determined by the length of time the various motors are in use, rather than by their normal or aggregate capacity. It may happen, owing to the intermittent use of machines and motors, that the generating plant may be reduced to 50 per cent., or even to 20 per cent., of the aggregate normal capacity of the motors out in the establishment. An increase of the electrical system can only be intelligently made from a careful study of the load curves of the existing installation, and using it as a basis for comparison with the portable load curve under the proposed conditions. There should be judicious subdivision of the generating plant into units, preferably of the same size and style, that they may be readily interchanged and duplicated at any time, with one or two relay units for emergencies and extra rush seasons of work.

Separate service circuits, from the same or separate busbars, may be provided to advantage, for lighting and various power uses. Sub-stations, or sub-station switchboards, should be provided for separate shops, floors, departments, or buildings, making it unnecessary to run a separate set of wires back to main switchboard for each service.

As far as practicable, each unit of the generating plant should be operated at its normal capacity—additional units to be switched in as may be required by the manufacturing conditions. Rarely the case that any machine or tool is started from rest with full load upon it. Motors may be started best under the usual friction, or light loads on the machines, as in the belt systems. When the machine is brought up to proper speed, work may be thrown on to it. In this respect the practical operation of an individual electric drive follows closely that of the belt system.

It is always possible to tell exactly what is going on in an electric drive, both in kind and amount of useful work, as well as in matter of wastes and losses. Power measurements are made at any point by ammeter and voltmeter, or by a wattmeter alone. A special test motor of known performance lends itself admirably to comparative tests of the performance of machines and tools under various conditions. Workmen may know at any moment whether they are driving tools or machine to best advantage for maximum output at best speeds.

The definite power required for definite work may be determined and charged to each machine, tool, or piece of work, and so make up the shop cost of production more exactly than by any other system. The power lost in friction of individual machines when running empty may be obtained with equal facility and compared with that required in doing useful work. It will be found that the latter increases almost directly as the resistance being overcome by the machine in its operation under working conditions. The power required by the work is a small per cent. of the total power delivered to the machine.

MANGANESE BRONZE STAYBOLTS.

A careful study of the staybolt problem made by M. du Bousquet, Chief Engineer of Material and Traction of the Northern Railroad of France, is worthy of record in staybolt literature. This investigation was brought about by the serious trouble which occurred from the failure of copper staybolts almost immediately after that road had put into service some new locomotives having steam pressures as high as 199 to 213 lbs. per square inch. The breakage of these staybolts increased as the engines were continued in service.

To study this trouble, drawings of the two sides and end sheets of a boiler of this class of locomotive were sent out on the road showing by small crosses the location of each staybolt in the firebox. In every case the failure of a staybolt was marked with a circle on the drawing representing that sheet. From these reports the general office made diagrams repre-

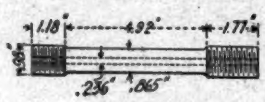


Fig. 1.

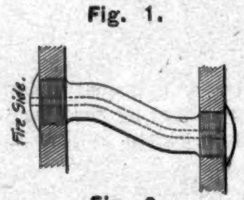
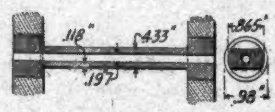


Fig. 2.



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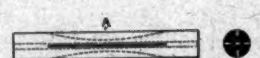


SECTION A-B.

Fig. 4.

senting the sheets of the firebox, only in this case the diagrams were divided into spaces of one (square) centimeter, each space representing a staybolt. By blackening a square millimeter of the space representing a particular staybolt each time a rupture occurred, a diagramatic record of every staybolt in the firebox was obtained. This revealed at a glance the part of the firebox where the greatest number of failures occurred and furnished material on which to base an investigation. After extensive trials with copper staybolts threaded only on the ends, as shown in Fig. 1, and increasing the diameter as shown in Fig. 2 with no success, another line of experiments was undertaken, using chiefly iron and steel staybolts

reduced in cross section, as illustrated in Fig. 3. These were made first of soft steel and then of nickel steel, but with no better results.

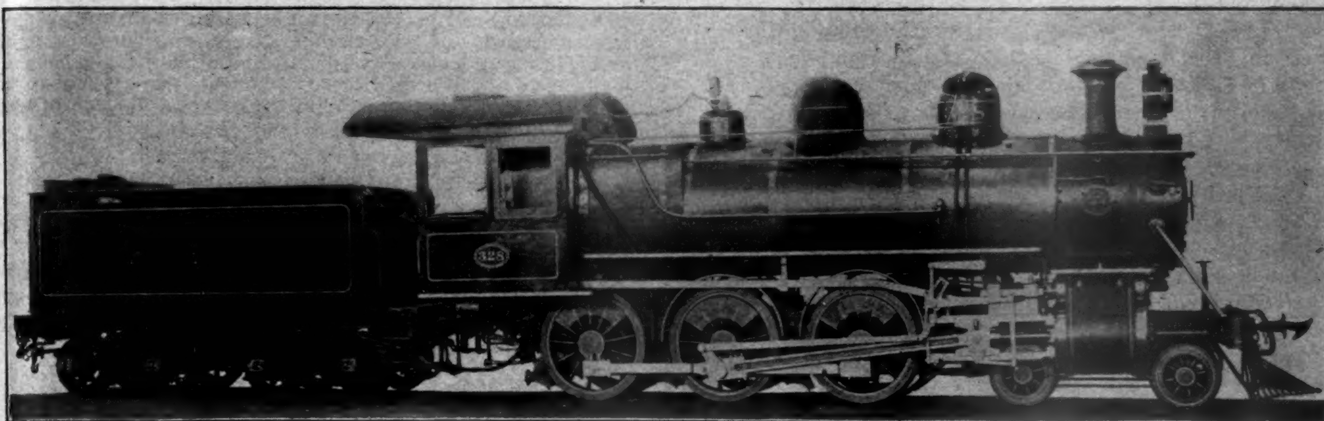
Reports of a metal called manganese bronze led M. du Bousquet, in April, 1896, to experiment with it for use in staybolts. The results from a series of physical tests of this metal, both hot and cold, are given as follows: Pulling tests were made on specimens 0.59 in. diameter and 3.94 ins. long between the shoulders of the specimens. In the cold test the mean resistance to breaking was 44,945 lbs. per square inch, with an elongation of 39.4 per cent. At 100 degs. Cent. the breaking strength was 47,079 lbs. per square inch, elongation 34.9 per cent.; at 200 degs. Cent. (392 degs. Fahr.) breaking strength 44,234 lbs. per square inch, elongation 34.2 per cent. Drifting tests showed excellent quality, as did bending tests. The results showed that this manganese bronze was notably superior to copper in the cold tests and incomparably superior in the hot tests, for copper at 200 degs. Cent. breaks at 22,330 lbs. per square inch, the elongation being about 34 per cent.

Staybolts of this metal were first used in 1896 to replace the old ones made of copper, in the three upper rows of the side sheets of certain high-speed locomotives. Afterward they were used to replace all broken staybolts in about 20 passenger locomotives, and finally, in 1900, the firebox of engines Nos. 2,641 and 2,642, carrying a steam pressure of 227.5 lbs., were completely fitted with these staybolts. The Northern Railroad of Belgium has also fitted with these manganese staybolts the fireboxes of six of their new passenger locomotives having steam pressure of 213 lbs. Since the trial of these staybolts in 1896 by M. du Bousquet 3,500 have been placed in service, mostly in those parts of the firebox where frequent ruptures occurred. Records kept of these bolts showed that up to December 10, 1900, a period of about four years, not one had been found broken, and their application has greatly decreased the trouble. In the first three months of 1897 the breaking of copper staybolts in 40 locomotives was at the rate of 543 per month. In the first three months of 1898 this average had fallen to 379 per month; in the first three months of 1899 to 148, and for the first three months of 1900 to 99. An analysis of this metal revealed the fact that only copper and manganese are used, the percentage of manganese being about 3 or 4. This road is also considering the use of firebox tube sheets of manganese bronze. Another metal investigated for staybolt use on the Northern Railroad was "Stone bronze" of special composition, which seems to have given good results in England. Fig. 4 gives a design of this bolt with four slots cut in the sides to give greater flexibility. In 1898 about 130 of these staybolts were put into service on a compound locomotive carrying 199 lbs. working pressure, and as yet no ruptures have been found. The complete record of these experiments may be found in the "Revue Generale des Chemins de Fer" for March, 1901, from which this abstract is taken.

TEN-WHEEL FREIGHT LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

Government of New Zealand Railway.

We have received from the Baldwin Locomotive Works a photograph of a design of 10-wheel freight locomotive with piston valves and the Walschaert valve gear for use in New Zealand. The engine is not large or heavy when compared with those in use in the United States, but is of special interest because of the application of this valve gear, which has important attributes which are attracting considerable attention in this country at this time, although, as far as we are informed, it is not yet being applied on any American road. The chief dimensions of these engines are as follows:



Ten-Wheel Freight Locomotive with Walschaert Valve Gear—Government of New Zealand Railway.

General Dimensions.

Cylinders.	
Diameter	16 ins.
Stroke	20 ins.
Valve	Balanced piston
Boiler.	
Diameter	52 ins.
Thickness of sheets	½ in.
Working pressure	200 lbs.
Fuel	Soft coal
Firebox.	
Material	Steel
Length	76 3/16 ins.
Width	30⅝ ins.
Depth	Front, 56½ ins.; back, 46½ ins.
Thickness of sheets	Sides, 5/16 in.; back, 5/16 in.; crown, ⅜ in.; tube, ½ in.
Tubes.	
Material	Steel
Number	177
Diameter	2 ins.
Length	13 ft. 4½ ins.
Heating Surface.	
Firebox	89.7 sq. ft.
Tubes	1,230.8 sq. ft.
Total	1,320.5 sq. ft.
Grate area	16 sq. ft.
Driving Wheels.	
Diameter outside	49 ins.
Diameter of center	44 ins.
Journals	6½ by 7 ins.
Engine Truck Wheels.	
Diameter	26 ins.
Journals	4¼ by 7½ ins.
Wheel Base.	
Driving	10 ft. 0 in.
Total engine	20 ft. 11 ins.
Total engine and tender	42 ft. 10 ins.
Weight.	
On drivers	63,580 lbs.
On truck	20,462 lbs.
Total engine	84,042 lbs.
Total engine and tender	125,000 lbs.
Tender.	
Diameter of wheels	28 ins.
Journals	3¾ by 7 ins.
Tank capacity	2,000 gals.

The new White Star Liner "Celtic," the largest ship ever built, arrived in New York August 3d, on her first voyage. She was out eight days and made an average speed of 14.95 knots, which is likely to be raised to about 16.5 knots in future voyages. The "Celtic" is 700 ft. long, 75 ft. beam and 49 ft. deep, with passenger accommodations for 2,859, and the gross tonnage is 20,888.

MACHINE TOOLS AT THE PAN-AMERICAN EXPOSITION.

These exhibits have already been referred to in this issue in a general way, but they merit further mention individually.

The Niles-Bennet-Pond Company, of New York, are the only exhibitors of heavy machine tools. They show a 60-in. Pond planer and lathe, a 5,000-lb. Bennet steam hammer and a Bennet vertical milling machine. From the Niles works there is an 84-in. boring mill and a large direct-driven radial drill with the motor mounted on top of the column. Adjoining this space is that of the Long & Alstatter Company, of Hamilton, Ohio, who exhibit a multiple punch for punching 40 5/16-in holes at once. They also exhibit a horizontal punch and bender, a standard 1-in. punch and a double angle shear.

American Tool Work Company, Cincinnati, Ohio.—This company has a number of their standard tools, which have been recently re-designed, among which are 2½-ft. and 5-ft. radial drills with back gears. They show a planer, motor driven, with the motor on top of the upright frame, also a 16-in. shaper with back gears, a 26-in. shaper with triple gears and several lathes.

The G. A. Gray Company, of Cincinnati, who make a specialty of planers, demonstrated the remarkable smoothness of the reversal of the beds by running them with glasses of water standing upon them. The water does not spill, although the glasses are full to the brim. One of the planers is 36 ins. and the other 30 ins. The larger one has the motor on the uprights driving through spur gears, while the motor of the smaller one is on the floor, driving by a screw. The smoothness of reversal is remarkable and attracts attention to the other features of the machines.

Bradford Machine Tool Company, Cincinnati.—This firm exhibits a number of lathes, the most noticeable of which is an engine lathe fitted with a turret attachment, which has tools for boring. They have another 21-in. engine lathe fitted with a novel feed belt tightener.

Bullard Machine Tool Company, Bridgeport, Conn.—Their machines are running and are specially well displayed. They show two turret lathes and four boring mills. All the mills are new. In the 42-in. machine a boring bar is fitted which has an adjustment by a rack and pinion in addition to that of the head. This permits of placing the tool while the feed is in gear. One of the mills has a turret and three of them have screw-cutting attachments.

The Prentiss Machine Tool & Supply Company have the most extensive exhibit, including the product of nearly a dozen machine tool makers. Among these the most prominent are the milling machines and attachments of the Cincinnati Milling Machine Company, the radial and multiple drills of the Bickford Drill & Tool Company, and the lathes of the Lodge & Shipley Company.

Prentice Brothers, Worcester, Mass., exhibit a number of drills, both radial and upright and a 24-in. engine lathe. This lathe merits careful attention. It is driven by a motor placed below the bed of the lathe, connected by gears. The motor speed is constant, all speed and gear changes being made by levers. This lathe operates so nicely that in screw cutting the tool comes to the shoulder and reverses without stopping the machine.

Pratt & Whitney, of Hartford, show about a dozen machines in operation, including several automatic screw machines making buttons for typewriters, valves for pet cocks and small bolts, also a mill machine, a 14-in. lathe, a 16-in. chasing lathe and deep hole drilling machines.

The Detrick & Harvey Machine Company, of Baltimore, exhibit a horizontal boring, milling and drilling machine, an open side planer, a nut facer and bolt cutter. The boring, milling and drilling machine will work at any angle, its work being secured to a universal table.

Becker-Brainard Milling Machine Company, Hyde Park, Mass.—This exhibit is devoted to their well-known milling machines and a new grinder for ordinary cutters, large mills with inserted teeth and for end mills. They also exhibit a new horizontal milling machine with vertical attachment.

The Cleveland Machine Screw Company, of Cleveland, have an interesting lot of automatic machines, the largest of which is an 18-in. automatic chucking machine which will take work up to a size of 18 by 18 ins., which may be held in a chuck.

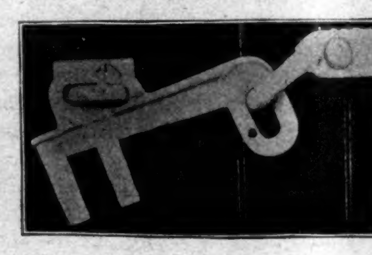
The Brown & Sharpe Manufacturing Company, of Providence, exhibit machine tools, hand tools, milling machines, gear cutters and have altogether a very interesting collection.

The Norton Emery Wheel Company, Worcester, Mass., have a very attractive and instructive exhibit which includes samples of the work of the Norton grinding machine which attracted attention at the Saratoga convention. They also exhibit a large line of emery wheels, including the largest one ever made. We are informed that the Midvale Steel Company have installed these grinding machines with the intention of grinding all of their car axles.

CAR-DOOR FASTENING AND VENTILATION.

A car-door fastening devised by Mr. F. A. Delano, General Manager of the Burlington, and Mr. R. D. Smith, Master Mechanic of that road, in Chicago, has recently been brought to our attention. It was developed to meet the peculiar requirements of a combination of a hasp which may be sealed with the door in the closed position, or with it open slightly, and also may be secured by a padlock when the car is used for bonded freight. At the same time the cost was required to be low and the device simple and durable. It was also necessary that it should be proof against thieves.

The result was the device known as the "Prairie Car-Door Fastener." It consists of a simple loop fastening attached to the door, a hasp with two hooks with seal slots, one of which engages the staple on the door post when the door is closed, and the other when the door is slightly open, and above these hooks is a loop for the padlock, whenever it is needed.



The Prairie Car-Door Fastener.

Its first cost is not greater than ordinary fastenings, it is easily sealed, and the lettering on the seal is readily seen. It may be used on regular or bonded cars, and with the car door slightly open the seal and lock are as secure as when it is closed. We do not know of any other combination of these features, and the exigencies of present-day traffic render such a device indispensable. The "Proceedings" of the Central Railway Club for May contain the following statement by Mr. H. H. Perkins, which shows the necessity for something of this sort:

"We do not have any trouble about the ventilation of box cars containing grain, but with fruit we do; the latter all goes in refrigerator cars now, which are either ventilated by leaving the ice doors open, or are practically ventilated by closing them and putting ice underneath and keeping the temperature down. Ventilated cars are very good for plums, cherries and strawberries. The New York Central has quite a number of these cars in which the doors are racked, and so the cars get good ventilation. This winter we had two refrigerator cars arrive here in Buffalo from Florida with oranges, and the heat in the cars when they arrived was over 120 degrees, and the oranges were nearly baked, while the thermometer in Buffalo was below zero. My explanation is that in Florida, at the time the oranges were loaded, it must have been a very hot day; the doors of the car were open so that the car became heated to that temperature; then the

oranges were placed in it and the doors tightly shut. Thus the car was practically an oven, and most of the oranges were ruined. In future, when we are drawing fruit from a southern climate to a northern one, in the winter, the ventilation will have to be regulated so as to let the cool air in down in Florida and shut the cold air out up here in Buffalo. Some refrigerator cars came from Baltimore, containing bananas, with ice doors open when they began the journey. Some one closed the ice doors en route. When they got here the bananas were baked. The thermometer stood at 148 degrees in those cars. We are settling the claim now."

This car-door fastener has been placed on the market by the J. S. Toppan Company, Great Northern Building, Chicago.

EFFECT OF SPLICING AND RIVETING.

Extracts from a paper read before the Western Society of Engineers by Mr. Geo. S. Morison, describing tests on riveted connections.

Four bars of soft steel were constructed by the American Bridge Company at its Pencoyd works, two of which were solid bars and two of which were cut in the center and spliced. In both of the spliced bars the holes were reamed. In one of them the splices were riveted on, and in the other they were fastened with close fitting turned bolts. The bars were all made of the same steel. These four bars were all broken in the Government testing machine at the U. S. Arsenal at Watertown, Mass., in January, 1901.

The solid bars broke in the body of the bar under strains averaging 56,915 lbs. per square inch, one of them showing a total elongation of 14.7 per cent. and a reduction of area at fracture of 53.5 per cent., and the other a total elongation of 18 per cent. and a reduction of area at fracture of 54.7 per cent. Each of the spliced bars broke in the rivet or bolt hole nearest to one of the heads, and showed comparatively small elongation but a large reduction at point of fracture, the elongation being respectively 3.6 and 3.7 per cent., and the reductions 45.6 and 43.5 per cent. The metal showed signs of overstraining and had begun to draw down opposite the rivet or bolt at the other end of the splice. All this was to be expected, as the full strain was taken here on the section of the bar reduced by the hole. The net section of the riveted bar at the rivet holes, which were 0.94 in. in diameter, was 76.5 per cent. of the full section of the bar. The net section of the bolted bar at the bolt holes, which were 0.87 in. in diameter, was 78.25 per cent. of the full section of the bar.

The mean ultimate strength of the spliced bars was 46,870 lbs. measured on the original section of the unspliced bar, or 82 per cent. of the mean ultimate strength of the solid bars. The mean elastic limit of the unspliced bars, according to the official reports, was 28,500 lbs., and that of the only spliced bar reported (the riveted bar) was 25,000 lbs., or 88 per cent. of that of the solid bars. A study of the elongations as plotted would seem to indicate that the yield point of the solid bars was practically 30,000 lbs., and of the spliced bars 26,000 lbs., or 87 per cent. that of the solid. All unit stresses are referred to the original section of the bar without allowance for reduction by holes or increase by metal in splices. But the average section of the spliced bars at the hole where the fracture occurred was 23 per cent. less than that of the solid bar, so that the actual stress per square inch where the fracture occurred was 6.4 per cent. more in the spliced bar than in the solid bar. The yield point was about 12 per cent. greater. This result is in accordance with those obtained in testing short specimens of ductile metal as compared with specimens of sufficient length to allow full contraction to occur. On the other hand, the form of these test bars allowed a considerable contraction to occur at the rivet or bolt hole where they broke.

The ultimate strength of the spliced bars was about 18 per cent. and the elastic limit about 12 per cent. less than that of the solid bars.

A study of the plotted elongations shows that below a stress of 26,000 lbs. per square inch, the elongations of the riveted bar were a little less than that of the solid bars, this difference evidently being due to the relief in the center of the bar given by the increased section of the splices.

A study of the plotted curves shows some instructive general results. Up to a 26,000-lb. stress the action of all the bars was practically the same, and if we exclude the bolted bar, the action may be said to be identical. After passing the yield point the action of the bars was practically the same until an elongation of 2 ins., or 1.25 per cent. of the gauged length, was reached. Above this the elongation of the spliced bars was considerably less than that of the solid bars, the difference being due to the larger section of the spliced portion of the bar.

In spite of the reductions in the elastic limit and ultimate strength, the action of the spliced bars was identical with the unspliced bars under all stresses which would be considered within permissible working limits on an actual structure.

On the basis of behavior under working stresses we should be justified in working the spliced bar up to the gross strain that we should put on a solid bar. On the basis of elastic limit we should be justified in working the spliced bar up to seven-eighths the gross strain we should put on a solid bar. On the basis of ultimate strength we should be justified in working the spliced bar up to nearly five-sixths the gross strain we should put on a solid bar. On the basis of net sections, after deducting for rivet or bolt holes, we should be justified in working the spliced bar up to a unit stress from 6 to 11 per cent. greater than we should put on a solid bar.

THE BULLOCK-WAGNER PAN-AMERICAN EXHIBIT.

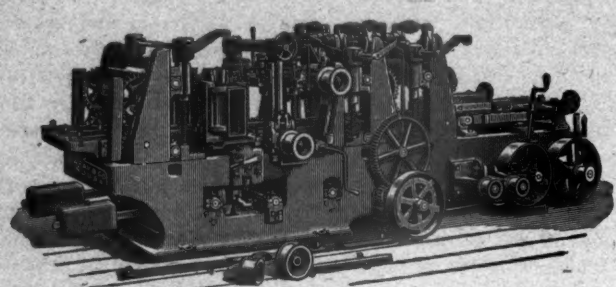
Visitors to the electrical building of the Pan-American Exposition are attracted to a splendidly arranged exhibit of the products of the Bullock and Wagner Manufacturing Companies, by a brilliant electric sign surmounting a heavy wooden background enameled in white and gold. In the center of the sign is reproduced the Bullock shield with the words Wagner on one side and Electric on the other, flashed by incandescent lights of four different colors on each side of the sign. The exhibits of the two companies are in two distinct sections, with the machines mounted on wooden pedestals. Nine different types of direct-current motors and controllers form the Bullock company's portion of the exhibit. Of these there are two generators of 150 and 25-kw. capacity, a 30-kw. belted generator, and motors of 50, 45, 20, 10, 9 and 2 h.p. Each of these machines has several particular advantages. The motors are built with either open or closed ends and may be belted or geared. They are designed to be placed either on the floor, ceiling or wall. The printing press controller is equipped with a hand wheel, the movement of which gives all speeds from full to an inch at a time.

The Wagner exhibit consists of single-phase alternating-current motors, transformers and switchboard panels equipped with voltmeters, ammeters, wattmeters and all switchboard instruments. These panels, of which there are four, form the middle lower part of the background of the exhibit. The three alternating-current motors have capacities as follows: 30-h.p., 208 volts; 5-h.p., 140 volts, and 2-h.p., 140 volts., and are all single-phase, 60-cycle, self-starting machines.

A centrifugal governor changes the armature connections when a certain speed is reached. Of the large number of transformers exhibited there is one 175-kw., with 18,500-volt primary and 1,100-volt secondary. This is one of a lot of 25 transformers built for the McCloud River Electric Power Company, of Washington, for which the Bullock and Wagner companies have the entire electrical contract. They show a 100-kw. transformer that is a new type of machine, having the air-blast inlet and exhaust in the base. There are also exhibited transformers from 25 to 1½-kw. capacity that are of the self-cooling type. These are all filled with oil, except the 1½-kw. transformer, which is filled with a solid insulating compound that the company finds is a more rapid conductor of heat than an air chamber around the coils.

NEW COMBINED PLANING, MATCHING AND JOINTING MACHINE.

A heavy six-roll, double-cylinder planing and matching machine has just been placed on the market by the J. A. Fay & Egan Company. This is the largest and heaviest combined planer and matcher made by this company and is especially adapted for railroad car and repair shops and planing mills. It will plane material 30 ins. wide, 14 ins. thick and will work simultaneously three sides of two pieces of material of uneven thickness up to 12 ins. wide and 14 ins. thick. The frame of the machine is massive, perfectly jointed and bolted to insure rigidity. The cylinders are made from solid forged steel and slotted on all faces. The matching devices are very substantial and



Double-Cylinder Planing and Matching Machine.

are fitted with a patent weighted matcher clip for working cross-grained and knotty lumber. This assures more rapid and accurate work. The feed rolls are eight inches in diameter, connected by a train of heavy expansion gearing with double links, heavily weighted. In the construction of the machine are embodied many devices of convenience for doing work in the most accurate and rapid manner. The builders will furnish upon application any information regarding this or any other of their special car shop wood-working machinery, and will also send free of charge their illustrated poster. The address of the J. A. Fay & Egan Company is No. 409 W. Front street, Cincinnati, Ohio.

BURNISHING CAR JOURNALS.

For a time there seemed to be but one opinion, and that favorable, concerning the advisability of burnishing or rolling the journals of car axles. At the recent M. C. B. convention the following conflicting opinions were expressed:

Mr. D. F. Crawford, of the Pennsylvania, said: "The rolling of journals has proven very advantageous, particularly in reducing materially, and in fact almost entirely eliminating, the trouble with hot boxes under new cars which are built at our own shops. In addition it has very materially reduced the number of hot journals under new cars built at outside shops, where the journals have been rolled we have had no trouble in loading the cars at once to their marked capacity, plus the usual 10 per cent. The advantages thus derived are so great that it would seem that if other roads have derived similar advantages, it might be well to have the rolled journals adopted as standard recommended practice, so that individual companies, as well as smaller railroad companies, having their cars built at outside shops, would insist on having the journals under their cars rolled, thus obviating the troubles from hot journals and loading under the capacity which has been found in the past."

Mr. Brazier, of the New York Central, stated that that road does not use the rolling process; the journals are put into high speed lathes and polished with emery.

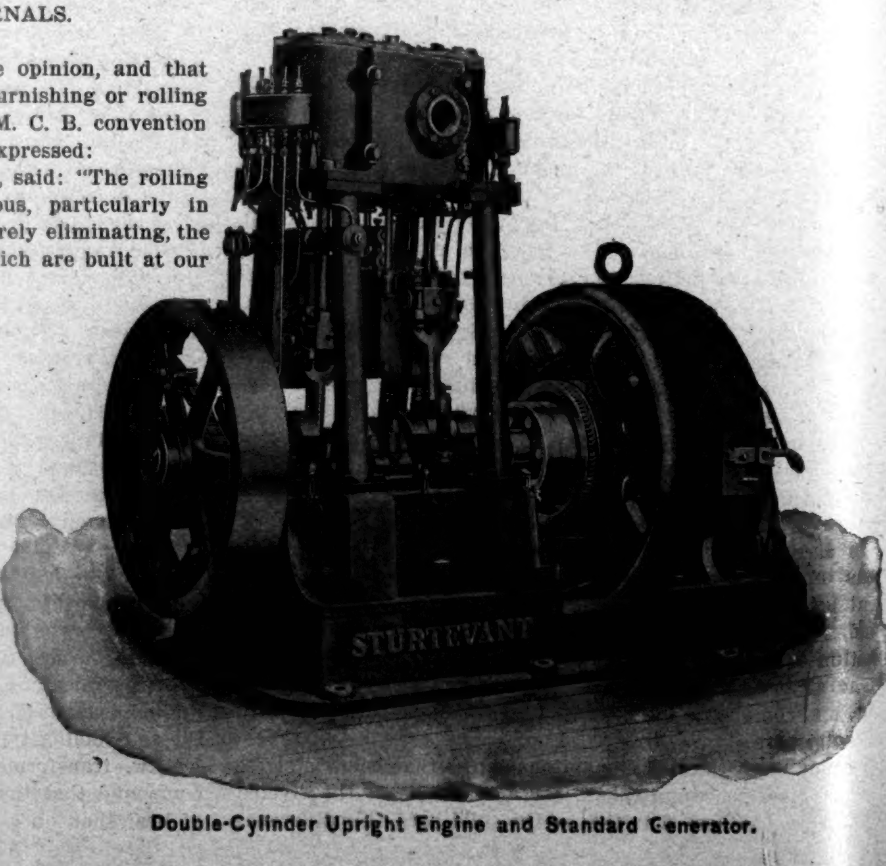
The opinion of Mr. Canfield, of the Philadelphia and Reading, was adverse. He said: "We do not think it is good practice to use the roller. The object of using it is to smooth the journal and roll down any particles of the iron or steel that may be standing up. It does that and would be all right if the journal always continued rolling in the same direction. But the minute you reverse the motion of the car and start it to roll the other way these particles are liable to be cut in the brass and give you trouble."

Mr. Hennessey, of the Chicago, Milwaukee & St. Paul, approved the practice: "We have had some experience in the use of rollers. We have built our equipment with exception of 500 cars, and for the last ten years rolled all the journals without any additional cost to the company. While doing the wheel fit we rolled the journal at the same time. We have had a large number of cars taken from the works and loaded them at once to half their capacity. We sometimes take the cars to the coal yards and load them to their full capacity. In something over 20,000 cars rolled we have never had one cut journal and the number of journals removed has not been worth considering."

A new process of finishing journals, that of grinding, has been recently offered and it seems to have important advantages over the rolling. It insures perfect roundness of the journals and it does not appear to be important which way they turn. Many of our readers saw the exhibit of piston rods and crank pins by the Norton Grinding Company at Saratoga.

A NEW GENERATING SET.

Within the past ten years the necessity of equipping large fans with means of driving other than by belt, has led to the design and manufacture of a line of distinctively fan engines. The rapid increase in the use of electricity as a motive power has also opened the way for the electric fan motor. Engines, generators and motors have been developed under the exacting conditions usually incident to fan practice, namely,



Double-Cylinder Upright Engine and Standard Generator.

high speed and constant operation requiring comparatively little attention. With these principles of a perfected generating set at hand it has been a relatively simple matter to combine them in a large line of many sizes, ranging from 1½ to 100 kilowatts.

One of the latest products of the B. F. Sturtevant Company, Boston, Mass., is illustrated in the accompanying engraving. It represents a double cylinder open type vertical engine and a 4-pole generator, both mounted upon the same bed. The engine is provided with three main journal bearings, the lower halves of which are brass bushed and provided with continuous oiling devices in connection with oil reservoirs beneath. The upright columns carry the single cylinder casting, which includes the two cylinders. Two piston valves are operated in unison by a single rocker and yoke, each regulating the admission of steam to one cylinder. They are fitted with snap rings and travel in removable bushings; the regulator is of the same general form as that used upon other types of upright engines. The cross heads are of the slipper type with projecting cross-head pins and the connecting rods have yoked cross-head ends. Both connecting rods and cross heads are of forged steel. These engines are built in sizes 8 x 5½ ins. and 9 x 5½ ins., having a rating of 47.5 and 60 h.p. respectively, and in material and workmanship are of the highest grade.

The generator is of the standard Sturtevant construction having the field cores cast on to the magnet steel frame. The bearings are of the ball-and-socket type and the armature of the barrel toothed drum type. The commutator consists of segments of pure copper secured between cast-iron flanges of spider construction which allow free circulation of air. All machines are fitted with carbon brushes mounted in holders of the sliding socket type. Each machine before being shipped is given a full load test for sufficient time to bring every part to maximum temperature, which does not exceed 40 degs. Cent. and is guaranteed to carry full rated load for ten hours without sparking at the brushes or overheating.

PERSONALS.

Mr. George H. Bussing has been appointed Master Car Builder of the Evansville & Terre Haute, with headquarters at Evansville, Ind.

Mr. Wm. J. Knox has resigned as Chief Draftsman of the Union Pacific, at Omaha, Neb., to accept a position with the Pittsburg Locomotive Works.

Mr. P. T. Dunlop, heretofore General Foreman of the Santa Fe shops at Newton, Kan., has been appointed Master Mechanic of the Gulf, Colorado & Santa Fe at Temple, Tex.

Mr. George B. Reeve, Second Vice-President and General Manager of the Grand Trunk, was elected President of the Atlantic & St. Lawrence Railway at a recent meeting of the directors of that road.

Mr. Grant Hall has been appointed Master Mechanic of the Pacific Division of the Canadian Pacific, with headquarters at Revelstoke, succeeding Mr. F. E. Hobbs, transferred to the Vancouver shops as General Foreman.

Mr. R. V. Wright, who was formerly with the Chicago Great Western at St. Paul, Minn., has been appointed Mechanical Engineer of the Pittsburg & Lake Erie, with headquarters at Pittsburg, Pa., to succeed Mr. J. H. Mitchell.

Mr. W. S. Lawless, for a number of years Foreman of water service of the Atchison, Topeka & Santa Fe, has been appointed General Foreman of the shops of that road at Topeka, Kan., in the place of Mr. F. P. Hickey, resigned.

Mr. Grant W. Lillie has resigned his position in the office of Superintendent Naval Constructor, at Newport News Ship Building & Dry Dock Co., to accept the position of Chief Draftsman of the Oregon Short Line in the place of Mr. W. C. Halstead, resigned.

Mr. William Gell has been appointed Locomotive Foreman of the Grand Trunk at Sarnia Tunnel, to succeed Mr. W. Kennedy, who has been made Master Mechanic at Montreal in the place of Mr. J. E. Muhlfeld, who recently accepted a position with the American Locomotive Company.

Mr. R. P. C. Sanderson, formerly Assistant Superintendent of Machinery of the Atchison, Topeka & Santa Fe, has been appointed General Purchasing Agent of the Seaboard Air Line, vice Mr. E. Belknap resigned to engaged in private business. Mr. Sanderson has had a wide and valuable experience on the Norfolk & Western and Atchison, Topeka & Santa Fe Railways. He will have headquarters at Portsmouth, Va.

Prof. Arthur L. Rice, in charge of the courses in mechanics and applied electricity at Pratt Institute, has resigned his duties at that school to become assistant to the secretary of the American Society of Mechanical Engineers. Mr. Rice is a graduate from Worcester Polytechnic Institute, in the class of 1891, and took several years of post-graduate work in electricity at this school and at Cornell. He will have charge of the development of the Society's library, its employment bureau and arrangements for the winter reunions, besides relieving the secretary of routine duties.

BOOKS AND PAMPHLETS.

Index of the American Railway Master Mechanics' Association Proceedings, from Vol. I. to Vol. XXXIII., inclusive. Compiled by George L. Fowler, M. E. Under the direction of F. A. Delano, S. P. Bush, C. M. Mendenhall, Committee. Price, $1. (Apply to Jos. W. Taylor, Secretary, The Rookery Building, Chicago.)

This, the first complete index of the proceedings of this association, is a very satisfactory production which will be appreciated by all who have occasion to refer to the records of this organization, which constitute a technical history of the progress of the locomotive and the mechanical departments of American railroads. Its chief value comes from the fact that it renders available in convenient form the entire records and what was impossible before, a study of the whole history of some particular practice, is now made not only possible but easy. By following in general the plans of the indexes of the engineering societies the committee did wisely and Mr. Fowler's compilation is done well. It is impossible perhaps to please everybody in a work of this kind, but the faults are such as may be easily remedied in future editions. The association is congratulated upon having the index and upon having such a good one. It contains 206 pages and is bound like the published proceedings. The price is $1.09 by mail.

Royal Wood Preserver.—This illustrated pamphlet, just issued by the Royal Wood Preserver Company, contains a short description of the cause and prevention of wood decay, together with other interesting matter regarding the treatment of wood. In railway service this preservative is used on stock, refrigerator and flat cars; railroad ties, trestle works, telegraph poles and cross arms; bridge timbers, piling, flooring and all woodwork above or below ground, in water or exposed to moisture or poor ventilation. It is self-penetrating and requires no skilled labor for its application, as this is accomplished by the use of a brush or by immersing the wood. A prominent feature of the pamphlet lies in the large number of photographic reproductions of strong testimonials, as to the merits of Royal Wood Preserver. These testimonials are from prominent firms whose knowledge is based on long continued use of this preservative. Those who use wood and are interested in lengthening its durability will find this pamphlet both valuable and interesting, and can procure a copy by addressing the Royal Wood Preserver Company, St. Louis, Mo.

Valves.—A small pamphlet has just been issued by the Homestead Valve Manufacturing Company, of Pittsburgh, Pa., describing the principal features of their locomotive blow-off, three-way, four-way and Homestead Junior valves, designed to meet every requirement of high pressure service. A brief description of how these valves operate is also embodied in the catalogue and a number of valuable testimonials from prominent firms using the Homestead valves.

A map of the Pan-American Exposition has been issued by the Westinghouse Companies, in which particular attention is directed to their exhibits. It is the best map of the grounds we have seen, and those who have not yet visited the exposition should send to the Westinghouse Company's Publication Department, Pittsburgh, Pa., for a copy.

The Knecht friction sensitive drill press is described in a small pamphlet issued by the Knecht Brothers Co., Cincinnati, Ohio. In a press of this kind, where the speed of the working tool changes in such short intervals, it is important to have the speed-controlling medium instantaneous and precise in its action. This feature, together with the driving mechanism, adjustable tension device and the simplicity and convenience of this press, are some of its points of excellence. The pamphlet also contains very favorable testimonials from railway and manufacturing companies.

Elevators and Conveyors.—A general idea of the very complete line of conveying machinery built by the Jeffrey Manufacturing Company can be gained from their little pamphlet No. 63, which has just been issued. The book is, with the exception of some short explanatory headings, a pictorial pamphlet giving photographic views of this company's elevators and conveyors in actual use; also a variety of buckets and screens for handling material of all kinds. Those who are interested in any particular line of these conveyors may procure the general descriptive catalogue by writing to the Jeffrey Manufacturing Company, Columbus, Ohio.

Carborundum.—The Carborundum Company, of Niagara Falls, N. Y., has sent a catalogue of 64 pages, containing a lecture on "The Manufacture and Development of Carborundum at Niagara Falls," delivered by Francis A. Fitzgerald, December 11, 1896, before the Franklin Institute. The pamphlet also gives additional notes on this company's products, including the characteristics of carborundum for grinding and polishing, the safety of such wheels, and their selection for high efficiency. A large list of working drawings of special wheels for well-known grinding machines are also included in the catalogue, together with a varied list of specialties, such as carborundum cloth, sharpening sticks and stones.

Bettendorf I-Beam Bolsters.—This catalogue illustrates several varieties of construction to which the Bettendorf I-beam bolster is adapted. These bolsters being made of standard I-beam sections, can be tapered to any required form to suit the standard trucks of any railway company. Particular attention is directed in this book to the construction and to the resistance which the parts of these bolsters offer in wrecks. No dependence is placed upon the rivets or connections to carry the load, as the I-beams are figured to be strong enough and are subjected to a central vertical load in a testing press sufficient to give 1 in. permanent set without any appreciable collapse at the ends. In the back of the catalogue are illustrated quite a number of photographic views and detail working drawings of various capacities of the Bettendorf double I-beam bolsters that are now in service on some of the principal railroads. This catalogue may be procured by writing to the Chicago office of the Bettendorf Axle Company, 1590 Old Colony Building, Chicago, Ill.

The Lowell Textile School catalogue for 1901-1902 presents an account of the very creditable work that is being done in that institution. The book gives a description of the five regular diploma courses offered in the theory and practical art of manufacturing all fibers known to the textile industry, also six different courses for evening students in which they can complete a thorough technical education without interfering with their daily duties. There is a woman's department, where the natural refinements of taste and skill of woman are brought out to excellent advantage in decorative art and textile design; also a commercial department for those contemplating a commercial career. The entrance qualifications of the school as given in the catalogue are low enough to admit anybody who has had an ordinary grammar school training. This school aims to aid those of the so-called "working classes" who desire to advance through the sacrifice of their otherwise spare time.

Industrial Opportunities.—This book, of 300 pages, issued by the Industrial Department of the Delaware, Lackawanna & Western Railroad, treats of all the towns on the lines of that road, showing the population, distance from New York and from Buffalo, the leading industries, the shipping facilities, rate of taxation, cost of labor, source and price of power, value of lands suitable for manufacturing sites, and all special inducements for the location of industries along these lines. The aim of this work is not only to be of valuable assistance to manufacturers, but through the location of new industries to expand and broaden the cities and towns. Copies of the book will be forwarded on application to Mr. W. B. Hunter, Industrial Agent of the Lackawanna Railroad, at 26 Exchange Place, New York.

EQUIPMENT AND MANUFACTURING NOTES.

The Barber trucks will be used under the following new equipment: One thousand box cars to be built by the Chicago, Milwaukee & St. Paul Railway at their West Milwaukee shops; 1,000 cars to be built by the Pressed Steel Car Company for the Erie Railroad; 1,100 box cars to be built by the American Car & Foundry Company for the Delaware, Lackawanna & Western Railroad, and 10 sets for locomotive tenders now being built by the American Locomotive Works at Richmond for the Baltimore & Ohio Railway.

Mr. W. H. Bryan, of St. Louis, with offices in the Lincoln Trust Building, has been retained as Consulting Engineer by the Shickle, Harrison & Howard Iron Company of that city. Mr. Bryan is a graduate of the Washington University, and an expert in electrical and mechanical engineering. The Shickle, Harrison & Howard Company are to be congratulated on securing the services of Mr. Bryan.

The Titan throttle valve, illustrated on page 259 of our August number, may be seen at the exhibit of the manufacturers, the Wm. Powell Company, of Cincinnati, at their exhibit in the machinery building at the Pan-American Exposition at Buffalo. This company also exhibits lubricators and a large number of other steam specialties.

The Chicago Grain Door Company has recently received a large number of orders for grain door equipment, including the following: Chicago Great Western, 800 box cars; Intercolonial of Canada, 800 cars; Illinois Central, 1,300 cars; Norfolk & Western, 250 cars; Chesapeake & Ohio, 300 cars; Canadian Northern, 600 cars, and Chicago, Milwaukee & St. Paul, 2,000 cars, together with 5,000 Security Lock Brackets used in connection with outside doors.

Another foreign shipment of steel cars left Pittsburg August 9 from the works of the Pressed Steel Car Company. This time the destination of the cars is Durban, Natal, South Africa, where they will be turned over to the Zululand Railway. The shipment consists of 10 flat cars of 50,000 lbs. capacity, and is an exact duplicate of a shipment made some time ago to the same railroad. The cars are 32 ft. long, 8 ft. wide and 3 ft. 3¼ ins. high. This is the third shipment of cars to South Africa made by the Pressed Steel Car Company within the last six months.

In the exhibit of the Buckeye Malleable Iron & Coupler Company at the Pan-American Exposition is included one of their new "Major" couplers, which are nearly ready for the market. This coupler has a very interesting lock, lock set and knuckle opener, all in one piece, which is entirely protected from external injury by being placed in a cavity inside the coupler head and operated by a chain passing through a hole in the top of the coupler. The lock has a wide bearing which covers the entire face of the knuckle arm at the lock bearing, which not only gives a secure lock, but also insures good wearing qualities. The coupler is strengthened by enlarging the pivot lugs and increasing the amount of wearing surface upon the inner face of the knuckle. This company also exhibits a draft gear and a new design for attaching the pocket straps to the coupler shank, whereby the shearing of rivets will be prevented. This gear has a spring capacity of 90,000 lbs. at each end and metal draft beams are used instead of wooden ones. The manufacturers will give a guarantee with this construction which should satisfy the purchaser.

SPECIAL PARTNER WANTED, with $25,000, to join with a reliable man of experience in developing a foreign business in Mining and Railway Equipment Specialties. Address correspondence W. K., Room 50, 105 Hudson St., New York City.